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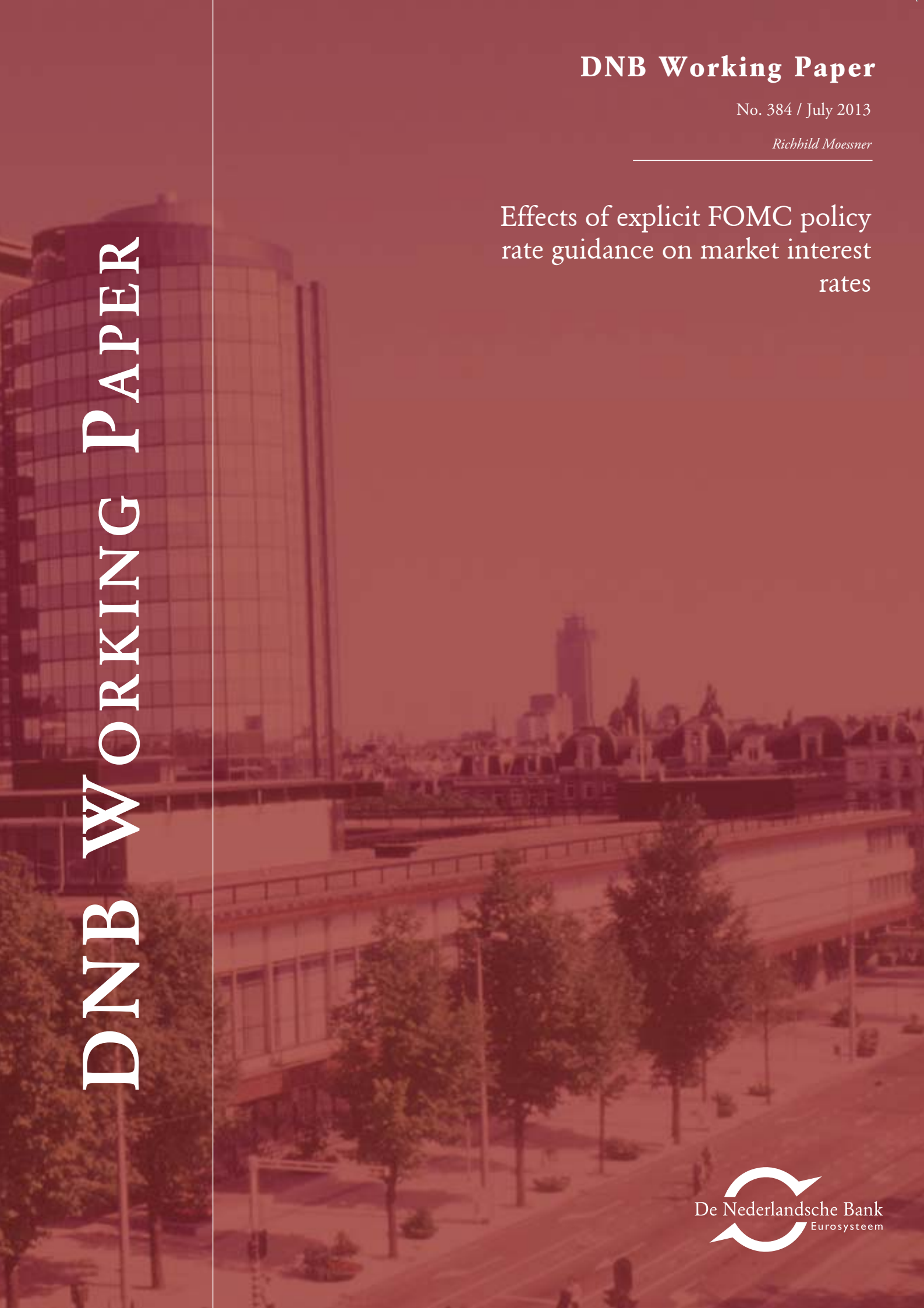

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* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

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Effects of explicit FOMC policy rate guidance on market interest rates*

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Abstract

We quantify the impact of explicit FOMC policy rate guidance used as an unconventional monetary policy tool at the zero lower bound of the policy rate on market interest rates. We study the impact on short- to medium-term interest rates implied by Eurodollar interest rate futures contracts, and on near- to long-term interest rates implied by US Treasury securities. We find that explicit policy rate guidance announcements significantly reduced interest rates implied by Eurodollar futures at horizons of 1 to 5 years ahead, with the largest effect at the intermediate horizon of 3 years. We also find that they significantly reduced forward interest rates implied by US Treasuries at horizons of 1 to 7 years ahead, with the largest effect at the intermediate horizons of 4 and 5 years. Moreover, we find that explicit FOMC policy rate guidance led to a significant reduction in the term spread, ie to a flattening of the yield curve, both for the Eurodollar futures curve and the US Treasury yield curve.

JEL classification: E58.

Key words: Monetary policy, central bank communication, policy rate guidance.

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1 Introduction

In this paper we quantify the impact of explicit FOMC policy rate guidance used as an unconventional monetary policy tool at the zero lower bound of the policy rate on market interest rates. We study the impact on short- to medium-term interest rates implied by Eurodollar interest rate futures contracts, and on near- to long-term interest rates implied by US Treasury securities with maturities up to 10 years.

With reaching the zero lower bound on policy interest rates in the wake of the global financial crisis, explicit policy rate guidance has become an important unconventional monetary policy tool for the FOMC, both for stimulating the economy while the policy rate is at the zero lower bound, and prospectively for contributing to managing an eventual exit from balance sheet policies (Bernanke (2011), Woodford (2012)). But little quantitative analysis has been performed of the effects of explicit policy rate guidance by the FOMC.

From a policy perspective it is important to quantify the effects of explicit policy rate guidance since explicit policy rate guidance is continued to be used in the United States as an important unconventional monetary policy tool, and is planned to be used in managing the exit from balance sheet policies. FOMC chairman Bernanke (2011) stated that "Then, as policy rates approached the zero lower bound, central banks began to employ an increasingly wide range of less conventional tools, including forward policy guidance and operations to alter the scale and composition of their balance sheets. Forward guidance about the future path of policy rates, already used before the crisis, took on greater importance as policy rates neared zero." The minutes of the FOMC meeting of 26-27 April (FOMC (2011)) mention that forward policy guidance will be changed as part of the exit from quantitative easing, "In addition, changes in the statement language regarding forward policy guidance would need to accompany the normalization process.". And Bernanke (2011) expects forward guidance to be continued to be used in normal times, in contrast to balance sheet policies, "In more normal times, when short-term policy rates are not constrained, I expect that balance sheet policies will be rarely used. By contrast, forward guidance and other forms of communication about policy can be valuable even

when the zero lower bound is not relevant, and I expect to see increasing use of such tools in the future.".

Carney, governor of the Bank of England, oversaw the use of explicit policy rate guidance as governor at the Bank of Canada, and stated that "While the Bank believes it appropriate to be sparing in forward policy guidance under ordinary circumstances, the calculus changes under extraordinary ones. When conventional monetary policy has been exhausted at the zero lower bound (ZLB) on nominal interest rates, the additional stimulus that is likely to be called for is impossible to achieve using the conventional interest rate tool. Extraordinary forward guidance is one unconventional policy tool, along with quantitative easing and credit easing." (Carney (2012)). The new remit for the Bank of England's Monetary Policy Committee effective from 20 March 2013 instructs the Monetary Policy Committee to assess in its August 2013 Inflation Report whether it is appropriate to introduce explicit policy rate guidance in the United Kingdom: "The Committee may also judge it to be appropriate to deploy explicit forward guidance including intermediate thresholds in order to influence expectations and thereby meet its objectives more effectively. This is likely to be most pertinent should the Committee judge spare capacity is likely to persist for a considerable period. The Government considers any use of intermediate thresholds to be a matter subject to the Committee's operational independence in setting policy, to be considered in these exceptional circumstances. The Committee is requested to provide an assessment of such approaches to setting policy alongside its August 2013 Inflation Report. This assessment should consider the merits of the approach in general, and of specific indicators and thresholds." (HM Treasury (2013)). In relation to this remit, the Monetary Policy Committee noted in a news release on 4 July 2013 following its policy meeting "The latest remit letter to the MPC from the Chancellor had requested that the Committee provide an assessment, alongside its August Inflation Report, of the case for adopting some form of forward guidance, including the possible use of intermediate thresholds. This analysis would have an important bearing on the Committee's policy discussions in August." (Bank of England (2013)).[1] The ECB introduced

[1]The MPC also commented on changes in market interest rates there for the first time since it was established, "The significant upward movement in market interest rates would, however, weigh on that

explicit policy rate guidance in July 2013. In the introductory statement to the press conference on 4 July 2013 following the ECB's Governing Council meeting, the ECB's President Draghi stated "The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time." (Draghi (2013)). This statement used the words "for an extended period", which had previously been used on 18 March 2009 by the FOMC in its explicit policy rate guidance (see Table 1).

Papers on central bank communication more generally include for example Andersson et al. (2006), Ehrmann and Fratzscher (2007) and Jansen and de Haan (2005). An overview of the literature on central bank communication is provided in Blinder et al. (2008), and Knütter et al. (2011) provide a recent survey on the effects of central bank communication on financial asset prices.

The previous literature on the impact of unconventional monetary policy in the United States has mainly focussed on the effects of asset purchase programmes (see eg D'Amico et al. (2012), International Monetary Fund (2013a), and references therein), rather than on the new unconventional monetary policy tool of explicit policy rate guidance.

Central banks in other countries have provided explicit policy rate guidance by publishing quantitative forecasts. The Reserve Bank of New Zealand has published interest rate forecasts since 1997. Moessner and Nelson (2008) and Detmers and Nautz (2012) analysed the effects of the Reserve Bank of New Zealand's published interest rate forecasts. Andersson and Hofmann (2009) studied the effectiveness of quantitative forward guidance for three inflation targeting central banks in Sweden, Norway and New Zealand. Kool and Thornton (2012) studied the effect of forward guidance on market participants' forecasting performance for interest rates in Sweden, Norway, New Zealand and the United States.

International Monetary Fund (2013b) provides an overview of the literature on the effects of central banks' unconventional monetary policies, focussing on bond purchases (with an accompanying background paper on bond purchases provided in International Monetary Fund (2013a)), but also including policy rate guidance. Chehal and Trehan

outlook; in the Committee's view, the implied rise in the expected future path of Bank Rate was not warranted by the recent developments in the domestic economy." (Bank of England (2013)).

(2009) and He (2010) studied the effect of explicit policy rate guidance in Canada. Campbell et al. (2012) analysed the effect of FOMC policy rate guidance more generally (including explicit policy rate guidance), using the method of Gürkaynak et al. (2005a) of decomposing news in FOMC statements into news about the target and the path of monetary policy. They found that forward guidance in monetary policy statements has significantly affected US Treasury yields since 2007. Gürkaynak et al. (2005a) found that the Federal Reserve's monetary policy statements affected interest rates mainly via their impact on expectations of future monetary policy. Woodford (2012) illustrates the effects of some instances of explicit FOMC policy rate guidance on OIS rates, but provides no quantitative analysis of the statistical significance. Swanson and Williams (2012) study the effect of the zero lower bound on medium- and longer-term interest rates in the United States by looking at changes in their sensitivity to macroeconomic news. They find that the sensitivity to macroeconomic news of yields with maturities greater than one year was high from 2008-10, but fell close to zero from late 2011. They argue that the latter finding may be due to the FOMC's policy rate guidance. They also study the time-varying sensitivity of Eurodollar futures rates to macroeconomic news, and relate its time profile to the FOMC's policy rate guidance. Maskin (2013) also studies changes in the sensitivity of short-term interest rate expectations to economic news, but using probability distributions of interest rate expectations derived from interest rate options, and finds that the introduction of the FOMC's date-based guidance in August 2011 led to a significant reduction in the sensitivity of the risk-neutral percentiles to economic surprises.

The contribution of this paper is to quantify the impact of explicit FOMC policy rate guidance used as an unconventional monetary policy tool at the zero lower bound, by studying its effects on short-, medium- and long-term interest rates implied by Eurodollar futures contracts and US Treasuries. This paper presents formal regression evidence focussing on the effects of explicit FOMC policy rate guidance, rather than on policy rate guidance more generally as in Campbell et al. (2012), and rather than illustrating the behaviour of interest rates at specific examples of explicit forward guidance as in Woodford (2012). The more general forward guidance included in Campbell et al. (2012) includes for example statements such as the one on 17 August 2007 that "the downside

risks to growth have increased appreciably", which is not explicitly guidance about the future path of the policy rate considered in this paper.

The outline of the paper is as follows. Section 2 presents the data, section 3 presents the method and results. Finally, section 4 concludes.

2 Data

As short- and medium-term market interest rates, we consider 3-month Eurodollar deposit interest rates implied by Eurodollar futures contracts expiring 0.25 to 5 years ahead from Bloomberg (Figure 1). An advantage of Eurodollar futures is that we can measure implied interest rates over a future time period directly from a traded contract, rather than having to infer them from spot rates which reflect average expectations from the present until the future period. Eurodollar futures also have the advantage that they are the most heavily traded futures contracts in the world, according to Swanson and Williams (2012).

[Figure 1 about here]

We also consider US Treasury instantaneous forward rates for short- to long-term horizons of 1 to 10 years ahead (Figure 2), and US Treasury zero-coupon bond yields of maturities from 1 to 10 years (Figure 3).[2]

[Figures 2 and 3 about here]

We also control for the effect of macroeconomic news on market interest rates by including surprises in 11 US macroeconomic indicators in the regressions. We use the same macroeconomic indicators as those included in Table 2 of Moessner and Nelson (2008). They are CPI inflation, GDP (advance), hourly earnings, housing starts, industrial production, the ISM manufacturing index, changes in nonfarm payrolls, PPI inflation,

[2]The series are computed following the methodology of Gürkaynak, Sack, and Wright (2006) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html (accessed on 25 March 2013).

retail sales, the trade balance, and the unemployment rate. The surprises of the real-time macroeconomic data releases are calculated relative to Bloomberg median survey expectations and are normalized by their standard deviation.

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 is for example described in Yellen (2012, 2013). On 16 December 2008 the FOMC introduced guidance that the federal funds rate would remain at exceptionally low levels "for some time", which was altered to "for an extended period" on 18 March 2009, to "at least through mid-2013" on 9 August 2011, to "at least through late 2014" on 25 January 2012, and to "at least through mid-2015" on 13 September 2012. This date-based guidance was changed to threshold-based guidance of "at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored" on 12 December 2012.[3] The dates when new explicit FOMC policy rate guidance was introduced and the wordings are given in Table 1, based on FOMC press releases. After a new wording of the FOMC's explicit policy 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.[4] 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. We therefore exclude the new guidance associated with the establishment of the target range

[3] See FOMC statements on the dates specified.

[4] The Federal Reserve Board started publishing target federal funds rate projections by Federal Reserve Board members and Federal Reserve Bank presidents on 25 January 2012, without assigning individual projections by name. Since this group contains non-voting members and is larger than the decision-making body of the FOMC, we do not study these projections in this paper, which considers explicit guidance by the FOMC on policy rates.

for the federal funds rate of 0-0.25% on 16 December 2008, since it was associated with a reduction of the target for the federal funds rate from its previous value of 1%.

[Table 1 about here]

3 Method and results

3.1 Effect on Eurodollar futures rates

We first regress daily changes in m-year-ahead Eurodollar futures rates (in percentage points), $y^m(t) - y^m(t-1)$, for short- and medium-term horizons of m =0.25, 1, 2, 3, 4 and 5 years ahead, 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, $surprise_j(t)$, $j = 1, ..., 11$, to control for the effects of economic data on market interest rates. The regression equation takes the form

$$y^m(t) - y^m(t-1) = c + a * d_{PRG}(t) + \sum_{j=1}^{11} (b_j * surprise_j(t)) + \sum_{k=1}^{20} f_k * (y^m(t-k) - y^m(t-k-1)) + \varepsilon_t \quad (1)$$

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 was reached, namely on 18 March 2009, 9 August 2011, 25 January 2012, 13 September 2012 and 12 December 2012 (Table 1), and zero otherwise. To control for serial correlation, we include 20 lagged differences of the dependent variable. We use White heteroskedasticity-consistent standard errors. Similar regressions have been widely used in the literature on the effect of central bank communication and news on financial asset prices (see eg the survey of Knütter et al. (2011)).

On some dates the FOMC's explicit policy rate guidance coincided with the FOMC's announcements regarding asset purchases as part of the first Large-Scale Asset Purchase Programme (LSAP1), LSAP2, the Maturity Extension Program (MEP) and LSAP3 (see Bernanke (2012) and 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, $d^{wap}_{PRG}(t)$,

$$y^m(t) - y^m(t-1) = c + a_1 * d^{nap}_{PRG}(t) + a_2 * d^{wap}_{PRG}(t) + \sum_{j=1}^{11} (b_j * surprise_j(t)) + \sum_{k=1}^{20} f_k * (y^m(t-k) - y^m(t-k-1)) + \varepsilon_t \quad (2)$$

The dummy variable $d^{nap}_{PRG}(t)$ takes the value of 1 on dates when the FOMC provided new explicit policy rate guidance but did not make announcements on asset purchases, namely on 9 August 2011 and 25 January 2012 as indicated by 'no' in column 3 of Table 1, 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 after the zero lower bound of the policy rate was reached, namely on 18 March 2009, 13 September 2012 and 12 December 2012, and zero otherwise. The dates of asset purchase announcements are those identifed in Hofmann and Zhu (2013).

We also test whether the explicit policy rate guidance affected intermediate horizons more than short horizons, by regressing daily changes in the term spread between Eurodollar futures rates 3 years ahead and one quarter ahead, $s(t) = y^3(t) - y^{0.25}(t)$, on the same exogenous variables as in equation (1),

$$s(t)-s(t-1) = c+a*d_{PRG}(t)+\sum_{j=1}^{11} (b_j * surprise_j(t))+\sum_{k=1}^{20} f_k*(s(t-k) - s(t-k-1))+\varepsilon_t \quad (3)$$

and as in equation (2),

$$s(t) - s(t-1) = c + a_1 * d^{nap}_{PRG}(t) + a_2 * d^{wap}_{PRG}(t) + \sum_{j=1}^{11} (b_j * surprise_j(t)) + \sum_{k=1}^{20} f_k * (s(t-k) - s(t-k-1)) + \varepsilon_t \quad (4)$$

[Table 2 about here]

We first present the results for estimating equation (1). We can see from Table 2 that the dummy variable for explicit policy rate guidance announcements is significant at the

5% level 2 to 5 years ahead, and at the 10% level 1 year ahead. The largest effect is present at the intermediate horizon of 3 years; on average, an individual announcement reduces 3-month Eurodollar futures rates by around 14 basis points. The reduction is smaller at the 1-year horizon, at 10 basis points, and there is no significant effect at the 1-quarter horizon. In addition to interest rate expectations, Eurodollar futures rates also reflect risk premia. Consequently, in addition to lower interest rate expectations, lower futures rates due to explicit policy rate guidance could also reflect decreases in risk premia, which could be associated with reduced uncertainty about the future path of interest rates due to the guidance. Gürkaynak et al. (2007) find that Eurodollar futures have better forecasting performance for future federal funds rates than other market-based measures of monetary policy expectations and econometric forecasts. At all horizons from 1 to 5 years, the effects of US economic data releases on Eurodollar futures rates[5] all have the expected sign where they are significant at the 10% level, and they are significant at the 10% level for 6 to 8 indicators at the different horizons; at the 1-quarter horizon, all 4 significant indicators also all have the expected sign. In all of the regressions presented in Table 2, the Ljung-Box Q-statistic for serial correlation is not significant for any of the first 36 lags considered. For all the regressions presented in Tables 3 to 9, the Ljung-Box Q-statistic for serial correlation is also not significant for any of the first 36 lags considered.

The previous literature on the impact of unconventional monetary policy has mainly focussed on the effects of asset purchase programmes, as discussed above. On some occasions announcements about asset purchases coincided with announcements of explicit policy rate guidance (Table 1). We therefore distinguish the effect of explicit policy rate guidance depending on whether it was associated with asset purchase announcements or not by estimating equation (2). We find that the dummy variable for policy rate guidance not associated with asset purchase announcements is significant at horizons of 3 to 5 years ahead at the 1% level, at horizons of 1 and 2 years at the 5% level, and at the 1-quarter ahead horizon at the 10% level (Table 3). The largest reduction in Eurodollar futures rates is present at the intermediate horizon of 3 years, with an individual announcement

[5] The results for the coefficients on US data releases, which are not reported in the tables, are available from the author upon request.

on average leading to a reduction of 18 basis points, while the corresponding reduction is only 6 basis points at the 1-year horizon and 2 basis points at the 1-quarter horizon. By contrast, the dummy variable for policy rate guidance associated with asset purchase announcements is not significant at any horizon. This suggests that the effect of policy rate guidance on Eurodollar futures rates is largest at intermediate horizons, and is not just a by-product of associated asset purchase announcements.

Daily changes in Eurodollar futures rates on the policy rate guidance announcement dates are shown in Figure 4, with those on dates not associated with asset purchase announcements shown as solid lines, and those on dates associated with asset purchase announcements shown as dashed lines. We can see that changes on dates associated with asset purchase announcements were more variable than those on dates not associated with asset purchase announcements. This is reflected in a larger standard error for the coefficient on the dummy variable $d_{PRG}^{wap}(t)$, which helps to explain why $d_{PRG}^{wap}(t)$ is not significant in Table 3. We can also see that the daily changes across the Eurodollar futures curve shown tended to be more negative on the dates of the earlier policy rate guidance announcements, became less negative for the later date-based guidance announcements, and became positive for the last threshold-based guidance announcement issued on 12 December 2012. The threshold-based guidance announcement might have brought forward market expectations of the date when the policy rate would increase. But we cannot distinguish between the effect of the policy rate guidance and of the asset purchase announcements on the dates when they coincided, as was the case for the threshold-based guidance, without information about market expectations of the announcements. None of the dates when policy rate guidance was associated with asset purchase announcements was an occasion when a new asset purchase programme such as LSAP1 was first announced; instead, all were subsequent announcements regarding a known programme (see Hofmann and Zhu (2013) for the asset purchase announcement dates). This might also help explain why the dummy variable $d_{PRG}^{wap}(t)$ is not significant, since the first announcement of a programme might be expected to contain the greatest news.

[Table 3 about here]

[Figure 4 about here]

We also test whether the explicit policy rate guidance affected intermediate horizons more than short horizons, leading to a flattening of the yield curve, which partly reflects the path for expected future policy rates. This was an intention of the explicit policy rate guidance: with very near-term policy rates already expected to remain close to zero at the zero lower bound, the policy rate guidance could not lower them much further; but interest rate expectations at intermediate and longer horizons could be lowered further if the guidance was effective. Results for the regression of the term spread between Eurodollar futures rates 3 years minus 1 quarter ahead of equations (3) and (4) are presented in Table 4. We find that the explicit policy rate guidance significantly reduced the term spread at the 5% level, with an individual announcement leading on average to a reduction of around 9 basis points. We can also see that policy rate guidance announcements not associated with asset purchase announcements had a more significant and larger effect on the term spread, being significant at the 1% level, and with an individual announcement leading on average to a reduction in the term spread of 16 basis points. By contrast, the policy rate guidance announcements associated with asset purchase announcements did not have a significant effect on the term spread.

[Table 4 about here]

3.2 Effect on US government bond yields

We next study the effect of explicit FOMC policy rate guidance on short- to long-term interest rates implied by US Treasuries. We perform the regression of equation (1) using as left-hand side variable daily changes in m-year-ahead US Treasury instantaneous forward rates (in percentage points), $y^m(t) - y^m(t-1)$, for short- to long-term expectations m =1 to 10 years ahead. Results are shown in Table 5. We find that explicit FOMC policy rate guidance leads to a significant reduction in US Treasury forward rates at horizons of 1 to 7 years ahead, with the reduction being most significant at horizons of 2 to 4 years ahead, namely at the 5% level, and with the reduction being largest at horizons of 4 and 5 years ahead, at 22-23 basis points on average per announcement. In addition to interest rate expectations, US Treasury rates also reflect risk premia. Consequently, in addition

to lower interest rate expectations, lower forward rates due to explicit policy rate guidance could also reflect decreases in risk premia, which could be associated with reduced uncertainty about the future path of interest rates due to the guidance, as discussed in the case of Eurodollar futures above.

[Table 5 about here]

We next also estimate the effect of explicit policy rate guidance on US Treasury forward rates m =1 to 10 years ahead, distinguishing whether announcements were associated with asset purchase announcements or not, according to equation (2). Results for the effects on daily changes in m-year-ahead US Treasury instantaneous forward rates are shown in Table 6. We find that explicit FOMC policy rate guidance not associated with asset purchase announcements leads to a significant reduction in US Treasury forward rates at horizons of 1 to 8 years ahead, with the reduction being most significant at horizons of 1 to 6 years ahead, namely at the 1% level, and with the reduction being largest at horizons of 4 and 5 years ahead, at 20-21 basis points on average per announcement. It is surprising that explicit FOMC policy rate guidance lowered US Treasury forward rates far into the future. This is consistent with the finding by Gürkaynak et al. (2005b) that long-term US Treasury forward rates react significantly to the unexpected components of many macroeconomic data releases and monetary policy announcements. It could reflect perceived changes by market participants of the FOMC's objective function. By contrast, explicit FOMC policy rate guidance associated with asset purchase announcements does not lead to a significant reduction in US Treasury forward rates at any horizon, so that the significant effect of explicit policy rate guidance we found in Table 5 is not just due to associated asset purchase announcements.

Daily changes in US Treasury forward rates on the policy rate guidance announcement dates are shown in Figure 5, with those on dates not associated with asset purchase announcements shown as solid lines, and those on dates associated with asset purchase announcements shown as dashed lines. As in the case of the Eurodollar futures curve, we can see that daily changes on dates associated with asset purchase announcements were more variable than those on dates not associated with asset purchase announcements.

This is reflected in a larger standard error for the coefficient on the dummy variable $d^{wap}_{PRG}(t)$, which helps to explain why $d^{wap}_{PRG}(t)$ is not significant in Table 6. We can again see that the daily changes across the US Treasury forward yield curve shown were more negative on the dates of the earlier policy rate guidance announcements, became less negative for the later date-based guidance announcements, and became positive for the last threshold-based guidance announcement issued on 12 December 2012, as discussed above for the case of the Eurodollar futures rates.

[Table 6 about here]

[Figure 5 about here]

We next perform the regression of equations (1) and (2) using as left-hand side variable daily changes in US Treasury zero-coupon bond yields of m-year maturity (in percentage points), $y^m(t) - y^m(t-1)$, for short- to long-term maturities of m =1 to 10 years. Results are shown in Tables 7 and 8. We find that explicit FOMC policy rate guidance leads to a significant reduction in US Treasury zero-coupon yields at maturities of 2 to 10 years, with the reduction being most significant at maturities of 3 to 5 years, namely at the 5% level, and with the reduction being largest at maturities of 7 to 9 years, at 17 basis points on average per announcement (Table 7). Moreover, we find that explicit FOMC policy rate guidance not associated with asset purchase announcements leads to a significant reduction in US Treasury forward rates at the 1% significance level for maturities of 2 to 10 years, with the reduction being largest at maturities of 6 and 9 years, at 15 basis points on average per announcement (Table 8). As in the case of US Treasury forward rates, we find by contrast that explicit FOMC policy rate guidance associated with asset purchase announcements does not lead to a significant reduction in US Treasury zero-coupon yields at any maturity, so that the significant effect of explicit policy rate guidance found in Table 7 is not just due to associated asset purchase announcements.

[Tables 7 and 8 about here]

Finally, we perform the regressions of equations (3) and (4), using the term spread implied by the US Treasury instantaneous forward curve from forward rates 5 years ahead

minus 1 year ahead, $s(t) = y^5(t) - y^1(t)$, as well as the term spread implied by the zero-coupon yield curve from yields of 5 year-maturity minus 1 year-maturity (Figure 6). We again find, as in the case of the term spread implied by Eurodollar futures rates above, that explicit policy rate guidance had a significantly negative effect on the term spread (Table 9). The effect is significant at the 5% level for the zero-coupon Treasury yield curve and at the 10% level for the forward curve considering all explicit policy rate guidance announcements. The effect is significant at the 1% level for explicit policy rate guidance announcements not associated with asset purchase announcements, but it is insignificant for explicit policy rate guidance announcements associated with asset purchase announcements.

[Figure 6 about here]

[Table 9 about here]

4 Conclusions

We quantified the impact of explicit FOMC policy rate guidance used as an unconventional monetary policy tool at the zero lower bound of the policy rate on short- to long-term market interest rates. We studied the impact on short- to medium-term interest rates implied by Eurodollar futures contracts, and on near- to long-term interest rates implied by US Treasuries with maturities up to 10 years.

We found that explicit policy rate guidance announcements significantly reduced interest rates implied by Eurodollar futures at horizons of 1 to 5 years ahead, with the largest effect at the intermediate horizon of 3 years. We found that explicit policy rate guidance announcements also significantly reduced forward interest rates implied by US Treasuries at horizons of 1 to 7 years ahead, with the largest effect at the intermediate horizons of 4 and 5 years. Moreover, we found that explicit FOMC policy rate guidance led to a significant reduction in the term spread, ie to a flattening of the yield curve, both for the Eurodollar futures curve and the US Treasury yield curve. We also found that, both for Eurodollar futures rates and US Treasury rates, the effect on implied interest rates of explicit policy rate guidance not associated with asset purchase announcements was more

significant than that of guidance associated with asset purchase announcements, so that the effect of explicit policy rate guidance was not just due to associated asset purchase announcements.

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Figure 1: Eurodollar futures rates, in percent

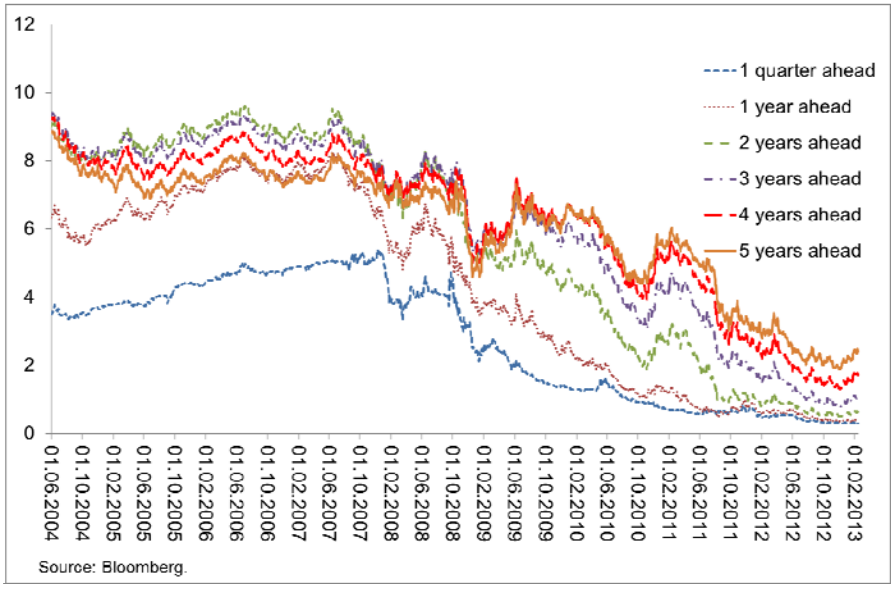
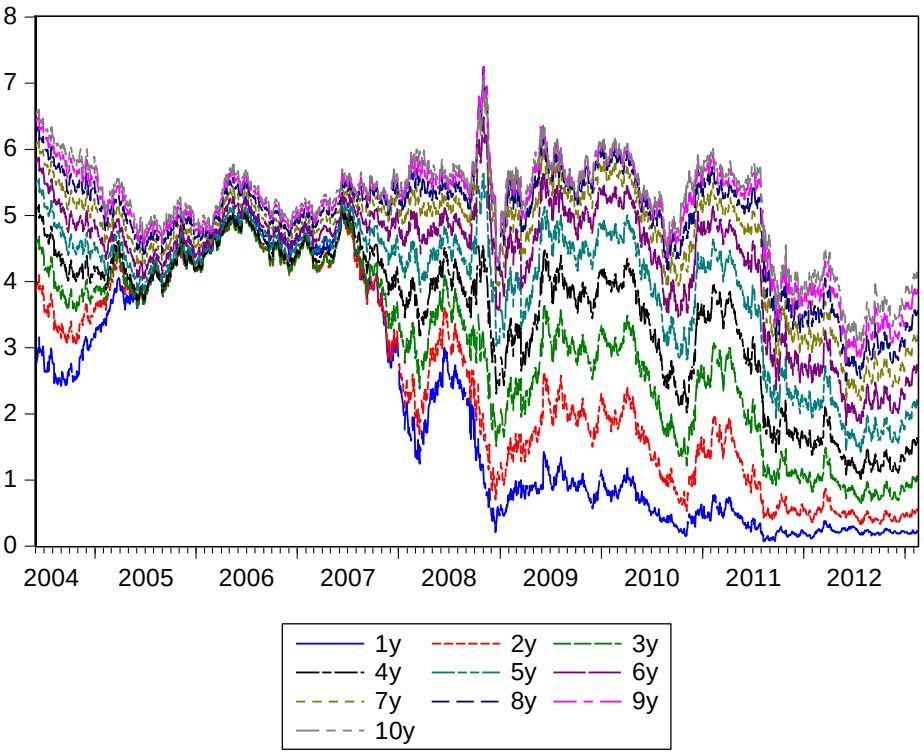
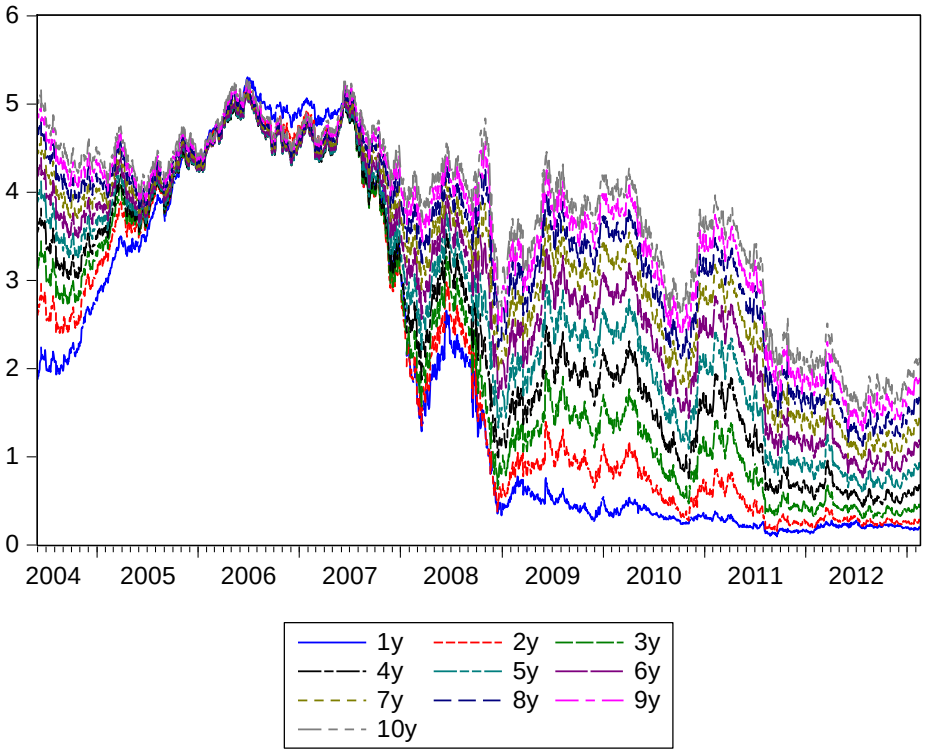


Figure 2: US Treasury instantaneous forward rates 1 to 10 years ahead, in percent



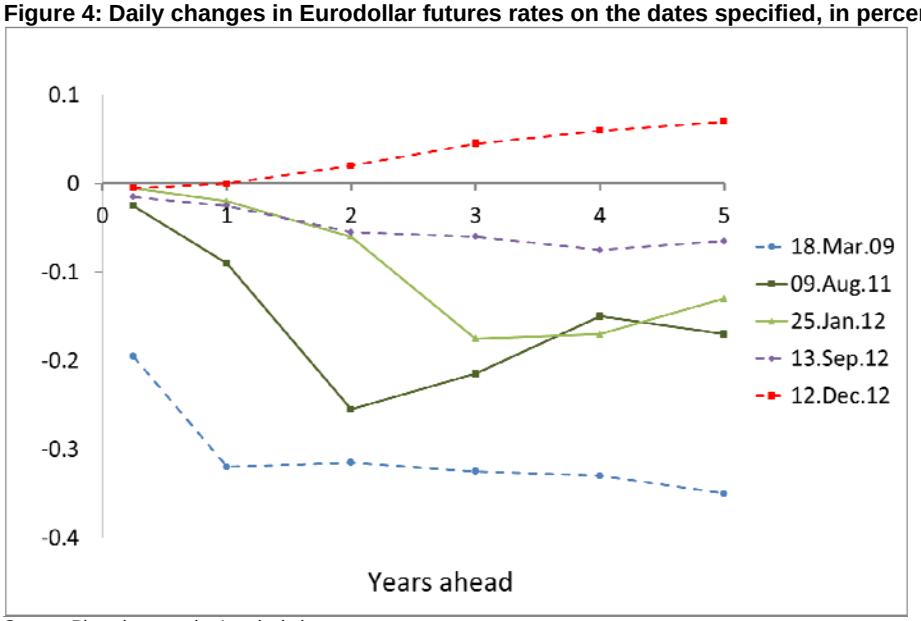
Source: Computed following the methodology of Gürkaynak, Sack, and Wright (2006) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html .

Figure 3: US Treasury zero-coupon yields with maturities of 1 to 10 years, in percent



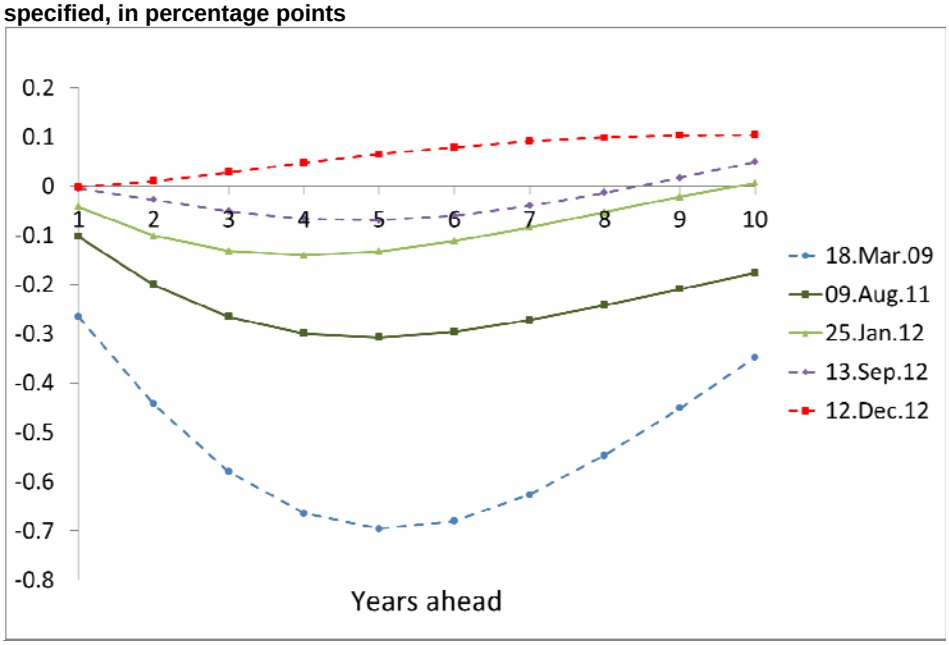
Source: Computed following the methodology of Gürkaynak, Sack, and Wright (2006) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html .

Figure 4: Daily changes in Eurodollar futures rates on the dates specified, in percentage points



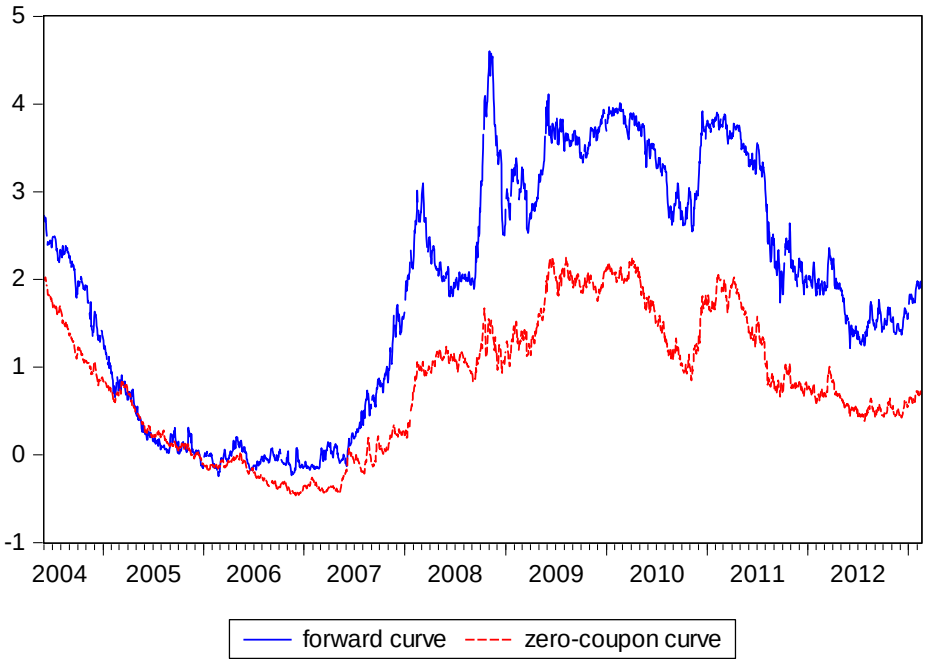
Source: Bloomberg, author's calculations.

Figure 5: Daily changes in US Treasury instantaneous forward rates 1 to 10 years ahead on the dates specified, in percentage points



Source: US Treasury instantaneous forward rates computed following the methodology of Gürkaynak, Sack, and Wright (2006) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html, author's calculations.

Figure 6: Term spreads of US Treasury yield curve, zero-coupon yields (5 years minus 1 year) and instantaneous forward rates (5 years minus 1 year ahead), in percentage points



Source: Computed following the methodology of Gürkaynak, Sack, and Wright (2006) as made available on the Federal Reserve website at http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html , author's calculations.

Table 1: Explicit FOMC policy rate guidance announcements

Date[a]	FOMC statements[b]	With asset purchase announcement?[c]	Main element of new guidance
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 percent. […] the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time […]	yes	some time
18 March 2009	[…] the Committee will maintain the target range for the federal funds rate at 0 to 1/4 percent and anticipates that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period.	yes	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.	no	mid-2013
25 January 2012	[…] the Committee expects to maintain a highly accommodative stance for monetary policy. […] 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. The Federal Reserve Board and the Federal Open Market Committee […] released […] the target federal funds rate projections made by Federal Reserve Board members and Federal Reserve Bank presidents […].	no	late 2014; policy rate path projections
13 September 2012	[…] the Committee expects that a highly accommodative stance of monetary policy will remain appropriate for a considerable time after the economic recovery strengthens. […] the Committee […] currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015.	yes	mid-2015
12 December 2012	[…] the Committee expects that a highly accommodative stance of monetary policy will remain appropriate for a considerable time after the asset purchase program ends and the economic recovery strengthens. […] 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 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored. The Committee views these thresholds as consistent with its earlier date-based guidance. In determining how long to maintain a highly accommodative stance of monetary policy, the Committee will also consider other information, including additional measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial developments. When the Committee decides to begin to remove policy accommodation, it will take a balanced approach consistent with its longer-run goals of maximum employment and inflation of 2 percent.	yes	thresholds

[a] Based on FOMC press releases. [b] From FOMC press releases. [c] Based on asset purchase announcement dates listed in Hofmann and Zhu (2013).

Table 2: Reactions of Eurodollar futures rates to explicit FOMC policy rate guidance

	Dependent variable: Changes in Eurodollar futures rates for period ahead					
Variable	1 quarter	1 year	2 years	3 years	4 years	5 years
c	-0.001	-0.002*	-0.003**	-0.003*	-0.002	-0.002
d_{PRG}	-0.052	-0.094*	-0.131**	-0.144**	-0.131**	-0.128**
Adj. R^2	0.099	0.074	0.071	0.066	0.056	0.051
No. of observations	2253	2253	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 3: Reactions of Eurodollar futures rates to explicit FOMC policy rate guidance, distinguishing whether or not associated with asset purchase announcements

	Dependent variable: Changes in Eurodollar futures for period ahead					
Variable	1 quarter	1 year	2 years	3 years	4 years	5 years
c	-0.001	-0.002*	-0.003**	-0.003*	-0.002	-0.002
d^{nap}_{PRG}	-0.021*	-0.055**	-0.146**	-0.176***	-0.141***	-0.133***
d^{wap}_{PRG}	-0.073	-0.119	-0.121	-0.123	-0.124	-0.125
Adj. R^2	0.100	0.074	0.071	0.066	0.055	0.050
No. of observations	2253	2253	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 4: Reactions of term spread of Eurodollar futures curve to explicit FOMC policy rate guidance

Dependent variable: Changes in term spread of Eurodollar futures rates 3 years minus 1 quarter ahead		
Variable	Equation (3)	Equation (4)
c	-0.001	-0.001
d_{PRG}	-0.094**	-
d^{nap}_{PRG}	-	-0.161***
d^{wap}_{PRG}	-	-0.050
Adj. R^2	0.044	0.045
No. of observations	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 5: Reactions of US Treasury forward rates to explicit FOMC policy rate guidance

Dependent variable: Changes in US Treasury instantaneous forward rates m years ahead										
Variable	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
c	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
d_{PRG}	-0.081*	-0.148**	-0.196**	-0.221**	-0.226*	-0.211*	-0.184*	-0.149	-0.111	-0.072
Adj. R^2	0.073	0.072	0.064	0.057	0.051	0.046	0.041	0.037	0.034	0.033
No. obs	2253	2253	2253	2253	2253	2253	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 6: Reactions of US Treasury forward rates to explicit FOMC policy rate guidance, distinguishing whether or not associated with asset purchase announcements

Dependent variable: Changes in US Treasury instantaneous forward rates m years ahead										
Variable	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
c	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
d^{nap}_{PRG}	-0.068***	-0.141***	-0.187***	-0.206***	-0.203***	-0.184***	-0.157**	-0.127*	-0.097	-0.069
d^{wap}_{PRG}	-0.090	-0.152	-0.202	-0.232	-0.241	-0.230	-0.202	-0.164	-0.120	-0.074
Adj. R^2	0.073	0.071	0.064	0.057	0.051	0.046	0.041	0.037	0.034	0.032
No. obs	2253	2253	2253	2253	2253	2253	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 7: Reactions of US Treasury yields to explicit FOMC policy rate guidance

Dependent variable: Changes in US Treasury zero-coupon yields with maturity of m years										
Variable	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
c	-0.0004	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
d_{PRG}	-0.047	-0.080*	-0.111**	-0.136**	-0.153**	-0.164*	-0.169*	-0.169*	-0.165*	-0.157*
Adj. R^2	0.067	0.076	0.075	0.073	0.070	0.067	0.065	0.062	0.059	0.057
No. obs	2253	2253	2253	2253	2253	2253	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 8: Reactions of US Treasury yields to explicit FOMC policy rate guidance, distinguishing whether or not associated with asset purchase announcements

Dependent variable: Changes in US Treasury zero-coupon yields with maturity of m years										
Variable	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
c	-0.0004	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
d^{nap}_{PRG}	-0.024	-0.064***	-0.098***	-0.123***	-0.140***	-0.149***	-0.153***	-0.152***	-0.148***	-0.141***
d^{wap}_{PRG}	-0.063	-0.092	-0.120	-0.144	-0.162	-0.174	-0.180	-0.181	-0.176	-0.168
Adj. R^2	0.067	0.076	0.075	0.072	0.070	0.067	0.064	0.062	0.059	0.057
No. obs	2253	2253	2253	2253	2253	2253	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

Table 9: Reactions of term spread of US Treasury yield curve to explicit FOMC policy rate guidance

Dependent variable: Changes in term spread of US Treasury yield curve				
	Instantaneous forward curve 5 years minus 1 year ahead		Zero-coupon yield curve 5 years minus 1 year maturity	
Variable				
c	0.000004	0.000004	-0.0001	-0.0001
d_{PRG}	-0.144*	-	-0.111**	-
d^{nap}_{PRG}	-	-0.133***	-	-0.118***
d^{wap}_{PRG}	-	-0.152	-	-0.106
Adj. R^2	0.044	0.029	0.040	0.039
No. obs	2253	2253	2253	2253

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors. Coefficients on surprises in 11 US macroeconomic variables and on lagged dependent variables not shown. Sample period: 6/30/2004–2/15/2013.

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