Monetary Policy Uncertainty and Monetary Policy Surprises

Michiel De Pooter, Giovanni Favara, Michele Modugno, Jason Wu[1]

First version: May 2018

This version: November 2019

Abstract

Does monetary policy uncertainty affect the transmission of monetary policy shocks to nominal and real interest rates? This paper provides empirical evidence suggesting the answer to this question is "yes": for a given monetary policy surprise, the reaction of nominal and real interest rates is more pronounced when the level of monetary policy uncertainty is low. To explain these facts, we provide evidence that in response to a monetary policy shock, primary dealers and other investors adjust their interest rate positions more when monetary policy uncertainty is low than when uncertainty is high. This adjustment likely arises because higher confidence about the future path of monetary policy actions leads investors to take riskier positions before a policy meeting. In such circumstances, the pass-through of monetary policy surprises to bond yields becomes more sizeable.

Keywords: monetary policy surprises, monetary policy uncertainty, interest rates, primary dealers

JEL Codes: E4, E5, G1.

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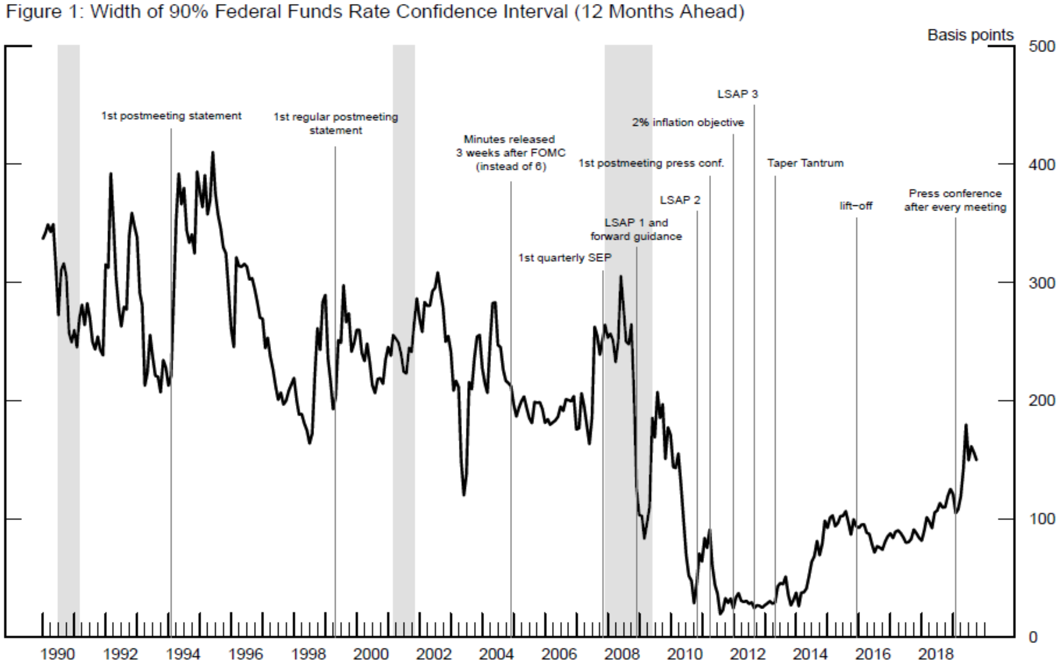
[1] De Pooter, Favara, and Modugno are at the Federal Reserve Board, Wu is at the Hong Kong Monetary Authority. Correspondence to giovanni.favara@frb.gov. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Federal Reserve Board, the Federal Reserve System, or the Hong Kong Monetary Authority. We thank Steven Davis, Luca Guerrieri, Refet Gürkaynak, Beth Klee, Barbara Rossi, Min Wei, Egon Zakrajsek as well as seminar participants at the Federal Reserve Board, the Advances in Applied Macro-Finance Conference at Bilgi University (December 2018), the Asset Pricing Workshop at University of York (June 2019), and the Money Macro & Finance Society 50th Anniversary Conference at London School of Economics (September 2019) for helpful comments and suggestions. All remaining errors are our own.

1. Introduction

Federal Reserve communications have changed significantly over the past two decades and have become increasingly transparent. For example, through the early 1990s, monetary policy decisions by the Federal Open Market Committee (FOMC) were not announced to the public. Today, the FOMC uses a range of tools to communicate its assessment of the economic and inflation outlook, its policy decisions, and its views about the policy path—including FOMC statements and minutes, post-meeting press conferences, the Summary of Economic Projections, as well as testimonies and speeches.[2]

In part reflecting these changes, the perceived uncertainty about the path of monetary policy in the U.S. has changed noticeably over time. Figure 1 shows one measure of this uncertainty based on Swanson (2006): the width of the market-implied probability distribution of the federal funds rate one year ahead, as implied by prices on interest rate derivatives. As is evident, U.S. monetary policy uncertainty fluctuated pronouncedly in the early 1990s and 2000s, reached a trough following the financial crisis, and has moved up again in recent years as the

Figure 1: Width of 90% Federal Funds Rate Confidence Interval (12 Months Ahead)



Note: Shaded areas denote NBER recessions.

[2] For an overview of how FOMC communications have evolved over the past two decades see for example Wynne (2013).

FOMC first began to lift the target range for the federal funds rate away from the zero lower bound at the end of 2015, before lowering rates again most recently.

Even with abundant transparency in FOMC communications, the market has at times been surprised by monetary policy announcements.[3] Our paper studies how the reaction in nominal and real U.S. interest rates to U.S. monetary policy surprises depends on the prevailing level of uncertainty surrounding the path of the federal funds rate. We show that the reaction of medium- and long-term interest rates to monetary policy surprises crucially depends on the level of monetary policy uncertainty. In particular, we find that a positive 10 basis point monetary policy shock is associated with a 11-basis-point increase in the 10-year nominal interest rate and a 20-basis-point increase in the 10-year real rate, if the future path of the monetary policy stance is perceived by market participants with "low uncertainty". In contrast, for a similar-size monetary policy shock, 10-year nominal and real rates increase only by 5 and 6 basis points, respectively, if the future path of the monetary policy stance is perceived with "high uncertainty".

To explain these findings, we conjecture that investors are more complacent about the future path of monetary policy actions—and therefore more willing to take riskier positions—when monetary policy uncertainty is low; in such circumstances, the pass-through of monetary policy surprises to interest rates is more sizeable as market participants have to adjust their interest rate positions more whenever a surprise materializes. Indeed, when we analyze the impact of monetary policy surprises separately on the expected rate and term premium components of bond yields, the latter tends to display a more sizable reaction to an unexpected change in the FOMC's monetary policy stance than the former; this reaction is inversely related to the level of uncertainty about the future federal funds rate.

Consistent with this conjecture, we find that primary dealers—the most important financial intermediaries in U.S. fixed income markets—adjust their net positions in Treasury securities more upon a monetary policy surprise when uncertainty is low than when uncertainty is high. A tightening monetary policy shock is associated with a statistically significant reduction in dealers' net long Treasury positions when uncertainty is low, whereas position adjustments are muted when uncertainty is high. Other market participants also behave similarly: the so-called "speculative"

[3] An obvious example of a recent monetary policy surprise was the "taper tantrum" episode in 2013, which saw a surge in interest rates and sizeable funding outflows from various asset classes.

positioning in interest rate derivatives, an often-used proxy of the net interest rate position of investors such as hedge funds and asset managers, also adjust by larger amounts in response to a monetary policy shock when uncertainty is low.

Our analysis is based on event study regressions. In the spirit of Hanson and Stein (2015) and Gilchrist, Lopez-Salido and Zakrajsek (2015), we use the change in the 2-year nominal Treasury yield in a 60-minute window around FOMC announcements as our main proxy of monetary policy surprises on FOMC days. This proxy summarizes surprise changes in the current federal funds rate and its expected path. We then study how medium- and longer-term U.S. nominal and real Treasury yields respond to a monetary policy surprise depending on monetary policy uncertainty as implied by federal funds futures and Eurodollar futures options. This measure of monetary policy uncertainty, described in Swanson (2006), is recorded on the day before each FOMC meeting and enters our regressions as an independent variable per se, as well as an interaction term with our proxy of monetary policy surprises. The interaction term allows us to evaluate the differential responses of nominal and real interest rates to monetary policy surprises as a function of the level of market-perceived uncertainty about the future path of monetary policy. The results from these first regressions show that the level of uncertainty is a key determinant for the response of nominal and real yields to monetary policy shocks.

Our second set of results, based again on event study regressions, provides evidence in support of the view that investors are more willing to take riskier positions when monetary policy uncertainty is low. Following Kim and Wright (2005) we decompose medium- and long-term nominal interest rates in their expectations and term premium components, representing the market-implied expectations for the future path of short rates and the compensation for bearing the risk of holding a long-term bond instead of a series of shorter-term bonds, respectively. We then use changes in each component as the dependent variable in our regressions, which allows us to determine which component drives our results for nominal yields overall. Our results show that the term premium is the dominant component, suggesting that the mechanism through which low uncertainty amplify policy shock pass-through to interest rates is one about investor risk-taking, rather than one about the re-evaluation of the economic outlook.

Our third set of results reveals the mechanism behind the first two results: using similar regressions but replacing the dependent variable by the 5-day change (around the day of a monetary policy announcement) in either the average dealer's net position in Treasury securities or the 5-day change in the speculative positions of investors in interest rate derivatives markets, we find strong evidence that primary dealers and other investors adjust their interest rate positions more abruptly upon a monetary shock when uncertainty is low than when uncertainty is higher. This evidence supports our interpretation that dealers and investors' increase their willingness to take riskier positions in the Treasury market when uncertainty is low, only to find themselves having to unwind those positions when an unfavorable policy shock arrives.

The main findings that monetary policy shocks have a sizable impact on long-term real interest rates are consistent with Hanson and Stein (2015), and Nakamura and Steinsson (2018). These two papers argue, however, for different mechanisms behind their results. Hanson and Stein (2015) find that monetary policy surprises affect long-term real rates through changes in term premia. In contrast, Nakamura and Steinsson (2018) emphasize that monetary policy surprises reveal important information about the state of economy, which affect the expectations component of long-term rates.

While we find that both components of interest rates respond to monetary policy shocks, our results are most consistent with the interpretation of Hanson and Stein (2015), as we show that uncertainty about the future path of monetary policy affects the transmission of monetary policy surprises to medium- and long-term yields predominantly through investors' willingness to take riskier positions, i.e. through the term premium. When a monetary policy surprise materializes, primary dealers and other investors change their net positions and by doing so affect the pricing of risk. In addition, changes in net positions are larger when market participants are more certain about the future monetary policy stance than when they are more uncertain.

As in the literature on economic uncertainty and firm behavior (see e.g. Bloom, 2014), in which greater uncertainty causes firms to temporarily pause investment and hiring decisions, our results indicate that when monetary policy uncertainty is high investors are less prone to bear risk. In such an environment, an unexpected monetary policy decision has a much smaller effect on medium- and long-term interest rates than periods in which uncertainty is low. In contrast to the literature on uncertainty and real decisions, however, we do not look at uncertainty as a source of shocks *per se*, rather we study how the level of monetary policy uncertainty amplifies or dampens the transmission of monetary policy surprises on medium- and long-term interest rates.

In this regard, a paper related to ours is Swanson and Williams (2014). They show that the response of bond yields to macroeconomic news is muted when monetary policy uncertainty is low. Swanson and Williams explain their findings by arguing that market participants tend to respond little to economic surprises when they have a great deal of confidence about the future path of monetary policy. In contrast, we find that the response of bond yields to monetary policy surprises is larger when monetary policy uncertainty is low. These apparently conflicting results can be reconciled through the view of Hanson and Stein (2015) that bond yield movements mirror the change in positions of yield-oriented investors. According to this view, the response of bond yields to a policy surprise is likely to be muted when monetary policy uncertainty is high, as yield-oriented investors that dislike large swings in the value of their portfolio may be reluctant to hold positions that subsequently need to be adjusted when a policy surprise becomes more likely or actually materializes.

Our results may also shed new light on the debate about the optimality of committing to a monetary policy rule. With a policy rule, e.g. Taylor (1993) or Taylor (1999), uncertainty about the way monetary policy decisions are reached is eliminated. However, unforeseen deviations from a prescribed policy rule may lead market participants to adjust their positions abruptly, possibly causing large fluctuations in term premia and long term interest rates.

The paper is organized as follows: Section 2 describes the data. Section 3 introduces our empirical framework. Section 4 presents the results of relating monetary policy surprises to medium- and long-term nominal and real interest rates depending on the uncertainty about the future path of monetary policy. Section 5 focuses on the interplay between monetary policy surprises and monetary policy uncertainty and their effects on the expectations and term-premium components of interest rates. Section 6 presents the estimates of broker dealer and other investor responses to monetary policy surprises. Section 7 concludes.

2. Data

Following Hanson and Stein (2015) and Gilchrist, Lopez-Salido and Zakrajsek (2015), we identify monetary policy shocks on FOMC days with the change in the 2-year nominal Treasury yield, in our case over a 60-minute window surrounding an FOMC announcement.[4] Since no other economic news is typically released during these time windows, changes in short-term interest rates can reasonably be attributed to policy decisions and other FOMC communications that were not anticipated by market participants.[5] Underlying this measure of policy surprise is the assumption that changes in the 2-year yield capture both surprise changes in the federal funds rate and in its expected path. This allows us to identify monetary policy surprises during both the conventional and the unconventional monetary policy regimes, while acknowledging the consensus in the literature (Gürkaynak, Sack, and Swanson (2005) and Campbell, Evans, Fisher, and Justiniano (2012)) that communications about the future path of the federal funds rate are the primary form of monetary policy news on FOMC announcement days.

The data on 2-, 5-, and 10-year nominal Treasury yields are described in Gürkaynak, Sack and Wright (2007). We also use 5- and 10-year real Treasury yields, derived from prices on Treasury Inflation-Protected Securities as described in Gürkaynak, Sack and Wright (2010). These nominal and real Treasury yields are updated regularly by staff at the Federal Reserve Board and are available on the Federal Reserve Board's website.[6] Both sets of zero-coupon yields are derived daily from prices on all outstanding Treasury securities (subject to some data filters) using the Svensson-Nelson-Siegel yield curve estimation approach, see Svensson (1994) and Gürkaynak, Sack and Wright (2007) for details.

We use Kim and Wright (2005) to decompose nominal Treasury yields into their expected rate and term premium components. Kim and Wright (2005) use the Gürkaynak, Sack and Wright (2007) nominal yields as input in a three-factor no-arbitrage term structure model to fit and estimate the dynamics of yields over time. The estimated term structure model allows us to decompose yields of any maturity into their average expected short rate and term premium components. Relative to the original Kim and Wright (2005) estimation, we use an updated set of parameter estimates based on an expanded data sample.

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[4] We show in robustness exercises in the appendix that our main results are robust to using other proxies of monetary policy shocks as well to using different event window lengths.

[5] This is a plausible assumption, as FOMC announcements have mostly occurred at either 12.30p.m., 2:00pm or 2:15p.m., while major macroeconomic data are usually released at either 8:30a.m. or 10:00a.m., and corporate news is typically released after 4:00p.m.

[6] For the nominal yield curve data see https://www.federalreserve.gov/econresdata/researchdata/feds200628.xls while for the real yield curve data see https://www.federalreserve.gov/econresdata/researchdata/feds200805.xls.

To measure uncertainty about the future path of monetary policy, we follow Swanson (2006) and Swanson and Williams (2014) and use the width of the market-implied distribution for the expected federal funds rate, in our case at the one-year horizon, as implied by interest rate derivatives prices.[7] We closely follow Swanson (2006) in the construction of our measure. We first construct the implied path for the federal funds rate using fed funds futures contracts. Then we use prices of at-the-money eurodollar futures options at different horizons to back out the implied volatility of the underlying eurodollar rate. We next adjust these implied volatilities for the level difference in volatility between the federal funds rate and eurodollar rates to estimate implied volatilities for the federal funds rate. Finally, using these implied volatilities we obtain an implied distribution for the federal funds rate at several fixed horizons, and use the distance between the 5th and the 95th percentiles of the implied federal funds rate distribution at the one-year horizon as our selected measure of uncertainty. This measure, expressed in basis points units, is plotted in Figure 1.[8]

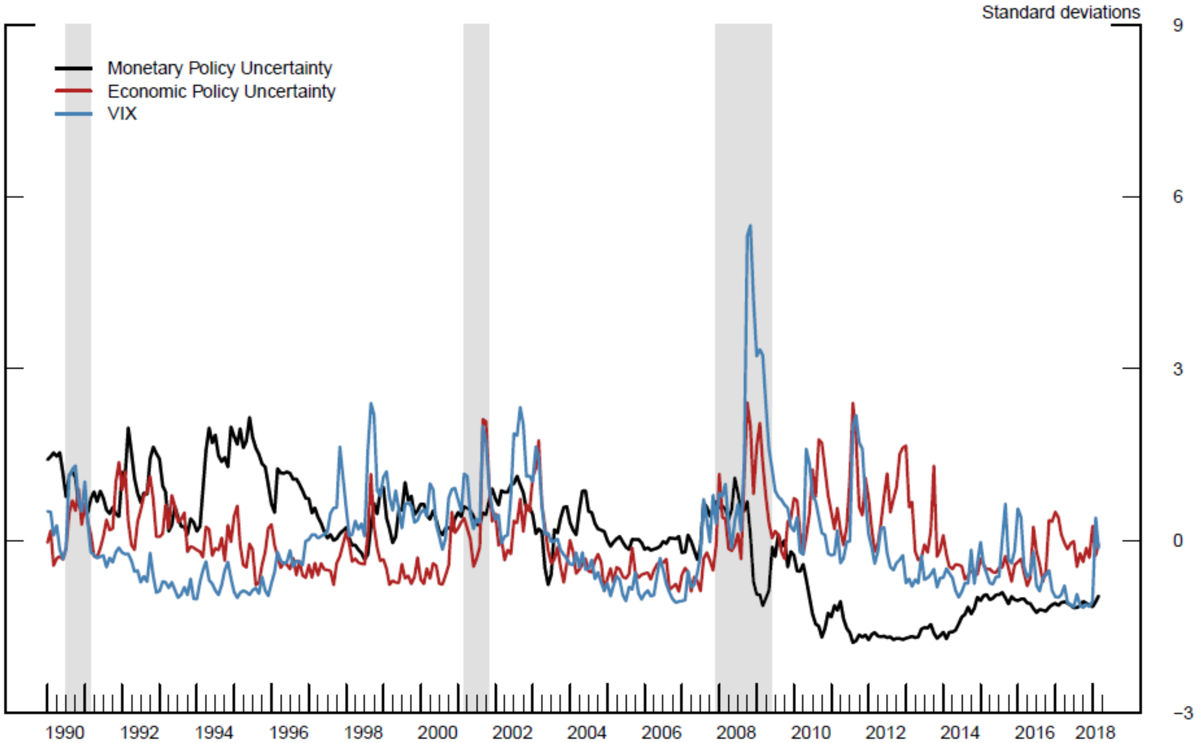
Figure 2 compares our measure of monetary policy uncertainty with two common proxies for uncertainty: the VIX—the stock market volatility index constructed by the Chicago Board of Options Exchange—and the EPU—the economic policy uncertainty index proposed by Baker, Bloom, and Davis (2016). These two alternative indexes capture a broader concept of uncertainty, and we use them in our empirical exercises as control variables.[9] As shown, the three measures comove but also have independent variations: the correlation between our measure of monetary policy uncertainty and the VIX is only 23 percent, while the correlation with the EPU is just 12 percent. Our measure of monetary policy uncertainty captures specific episodes of uncertainty related to FOMC decisions, especially the mid-90s and during the zero lower bound period, that the other two measures of uncertainty are not able to capture.

[7] Swanson (2006) uses the same measure of monetary policy uncertainty as we do here to argue that since the late 1980s increased Federal Reserve transparency has contributed to market participants' ability to forecast future FOMC interest rate decisions.

[8] We also explored used the 90% width of the distribution at shorter and longer horizons than 1 year but this did not materially change our results.

[9] The VIX is a popular forward-looking measure of uncertainty based on options with a 1-month expiration on the S&P 500 index. The Baker, Bloom, and Davis (2016) EPU index is an index of economic and political uncertainty based on news reported in leading U.S. newspapers. In Figure 2, the three uncertainty measures are recorded on the days before an FOMC meeting; they are also standardized in order to facilitate the comparison.

Figure 2: Monetary Policy Uncertainty, Economic Policy Uncertainty, and the VIX



Note: Shaded areas denote NBER recessions.

Our analysis also uses data on duration-weighted net positions of primary dealers in U.S. Treasury securities. The net positions data capture the directional exposure of primary dealers in U.S. Treasury cash securities and forward contracts. The net position data is available weekly for 23 primary dealers.[10] For investors on the other side of the market—such as hedge funds and asset managers—we proxy interest rate positions with weekly data from the Commodity Futures Trading Commission (CFTC). Each week, the CFTC reports the gross and net number of "speculative" derivative contracts, broadly defined as interest rate futures and options on futures contracts held for purposes other than hedging, across a number of interest rate tenors. We focus on aggregate duration-weighted net positions for the maturity buckets 0-3, 3-6, 6-11, and 11-30 years for the dealer data and the 2-, 5-, and 10-year maturities for the speculative positions. A positive number for these positions indicates that investors are overall "long" interest rates or, equivalently, betting on interest rates to go down, while a negative number is indicative that investors are "short" interest rates or, equivalently, betting on interest rates to go up. A negative

[10] The list of U.S. primary dealers can be found at https://www.newyorkfed.org/markets/primarydealers.html. The number of primary dealers has varied over time and there currently are 24 in total.

change in the CFTC positions suggest that speculators are reducing their net long positions or becoming even more “short”.

3. Empirical Framework

Our empirical framework follows Gürkaynak, Sack, and Swanson (2005), Gilchrist, Lopez-Salido and Zakrajsek (2015), and Hanson and Stein (2015), among others. We use changes in the 2-year nominal U.S. Treasury yield during 60-minute windows around FOMC announcements (from 15 minutes before to 45 minutes after announcements) as our proxy for monetary policy surprises. We then study the impact of these monetary policy surprises on medium- and long-term nominal and real Treasury yields, conditioning on the level of monetary policy uncertainty as perceived by market participants ahead of each policy meeting.

We employ the following regression framework:

$$\Delta y_d^m = a + \beta \Delta mp_d + \gamma Uncertainty_{d-1} + \delta \Delta mp_d \times Uncertainty_{d-1} + \Omega_{d-1} + \epsilon_d,$$

where d is the (second) day of a scheduled FOMC meeting; Δy_d^m is the two-day change from d-1 to d+1 in the nominal or real Treasury yield, with maturity m equal to either 5- or 10-years; Δmp_d is the 60-minute change in the 2-year Treasury yield around the FOMC policy announcement—our measure of monetary policy surprises; $Uncertainty_{d-1}$ is the one-year ahead measure of monetary policy uncertainty implied by federal funds futures and Eurodollar futures options, as plotted in Figure 1 and measured on day d-1, the day before an FOMC meeting.

Our regression framework posits that a monetary policy surprise, Δmp_d, affects yields directly through the parameter β, and that this effect varies with the level of monetary policy uncertainty through the interaction term parameter δ. In the rest of the paper, we will focus on the effect of a monetary policy surprise—the values of $\beta + \delta \times Uncertainty$—when uncertainty is in the 25th, 50th, or 75th quintile of its historical distribution. The joint significance of the β and δ parameters is tested via the delta method.

The vector Ω_{d-1} denotes a conditioning information set available the day before each FOMC meeting; it includes the level of the 2-year Treasury yield, which controls for the mechanical relationship between the level of interest rates and uncertainty about monetary policy.

The set of control variables also includes the VIX and EPU indexes, which are included to assuage the concern that the response of interest rates to monetary policy surprises may also depend on the level of economic and political uncertainty.

We compile a list of monetary policy announcement days starting in July 1991, the first FOMC meeting for which we have event-window data available for the 2-year Treasury yield, through December 2017. We also look at subsample data, in particular starting in May 1999, the first year the FOMC started releasing a post-meeting statement at each meeting regardless of the policy action taken.[11] Our sample consists of a maximum total of 221 scheduled policy announcements during the conventional (July 1991 to December 2008), unconventional (January 2009 to November 2015) and post-zero-lower-bound monetary policy regime (December 2015 to December 2017).[12]

4. Reactions in Nominal and Real Yields to Monetary Policy Surprises

Table 1 reports estimates of the response of nominal and real yields to a monetary policy surprise when the one-year ahead measure of monetary policy uncertainty is low, medium, or high—that is $Uncertainty_{d-1}$ is equal to values that correspond to the 25th percentile (94 basis points), median (207 basis points) and 75th percentile (259 basis points) of its historical distribution, respectively.[13] Columns 1 and 2 use the 5- and 10-year nominal rate as dependent variables, respectively; columns 3 and 4 use the TIPS-implied real rates for the same maturities.

The estimated effects suggest that positive monetary policy surprises, or "tightening" surprises, are associated with an increase in nominal and real rates, but this increase is muted during periods of high monetary policy uncertainty. Based on columns 2 and 4, a 10 basis point

[11] The beginning of this subsample also coincides with the first year in which prices of TIPS securities are deemed reliable enough from which to estimate a real yield curve.

[12] Note that we do not include unscheduled FOMC meetings and only focus on scheduled meetings. In a robustness check, following Hanson and Stein (2015), we also excluded some policy announcements after 2009 that contained significant news about the Fed's large-scale asset purchases (LSAPs), as long-term rate movements on these dates may be affected by factors other than those typically associated with conventional FOMC announcements. Although we do not report these results here, they show that our main results are robust to excluding this subset of announcements.

[13] These are the sample percentiles since July 1991. For the subsample starting in May 1999, these percentiles are 80, 178, and 233 basis points, respectively.

positive monetary policy surprise (approximately a two standard deviation move) is associated with roughly a 7 and 9 basis point increase in 10-year nominal and real rates, respectively, when

Table 1
Response of U.S. Treasury nominal and real yields to monetary policy surprises

	Dependent Variable			
	Nominal Yields		TIPS Yields	
	5-year	10-year	5-year	10-year
	(1)	(2)	(3)	(4)
Coefficients				
Δmp_d	1.442***	1.387***	3.422***	2.814***
	(4.51)	(3.15)	(7.03)	(5.54)
Δmp_d x $uncertainty_{d-1}$	-0.277*	-0.326*	-1.202***	-0.999***
	(-2.30)	(-1.95)	(-5.98)	(-4.74)
Evaluation				
Low Uncertainty	1.175***	1.073***	2.432***	1.992***
(25th perc.)	(5.49)	(3.71)	(7.42)	(5.89)
Medium Uncertainty	0.858***	0.699***	1.164***	0.938***
(50th perc.)	(7.26)	(5.06)	(7.98)	(6.87)
High Uncertainty	0.727***	0.545***	0.556***	0.433***
(75th perc.)	(6.66)	(4.62)	(5.10)	(4.92)
Observations	221	221	158	158
R-squared	0.29	0.19	0.46	0.40

NOTE: Reported coefficients denote the two-day response, around FOMC dates, of nominal and real U.S. Treasury yields (with five- and ten-year maturity) to monetary policy surprises for various levels of monetary policy uncertainty. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample period is July 1991 to December 2017 (nominal yields) and May 1999 to December 2017 (TIPS yields). ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

the level of monetary uncertainty is at its median value. The response of nominal and real rates increases to 11 and 20 basis points when the uncertainty about monetary policy is at the lower quartile of its distribution. In contrast, the responses falls to about 5 and 4 basis points when the uncertainty about monetary policy is at the upper quartile of its distribution. Table 1 also reveals that monetary policy surprises have a larger effect on real rates than on nominal rates, especially when uncertainty is low, implying that inflation compensation falls on a positive monetary policy shock. Indeed, under low uncertainty, the reaction in the 5-year real rate is about twice as large as the reaction in the 5-year nominal rate, while the 10-year real rate reacts 85% more than the 10-year nominal rate. However, when uncertainty is high, real yields tend to react somewhat less than nominal rates to a monetary policy shock.

These results are consistent with the event-study literature showing that monetary policy surprises have large effects on long-term interest rates (Gilchrist, Lopez-Salido, and Zakrajsek, 2015; Gertler and Karadi, 2015; Hanson and Stein, 2015; Altavilla, Giannone and Modugno 2017; Nakamura and Steinsson, 2018). Our findings complement these existing studies by showing that the pass-through of monetary policy surprises to longer-term yields depends on the prevailing level of monetary policy uncertainty. The Appendix at the end of this paper shows that our results are robust to several alternative specifications, including using forward rates as the dependent variable instead of yields; using alternative measures of monetary policy surprises; and using pre- and post-crisis subsamples.

5. Investigating the Mechanism

Table 2 decomposes the changes in nominal Treasury yields into changes in the average expected short rate component over 5- and 10-years (columns 1 and 2, respectively) and changes in the term premium components (columns 3 and 4), as estimated using Kim and Wright (2005). This decomposition is useful to assess whether low monetary policy uncertainty heightens the pass-through of policy surprises to expected future short rates or to the compensation demanded by investors for their exposure to bear interest rate risk on longer-term securities.

As shown in Table 2, the response of nominal rates to monetary policy surprises reflects predominantly changes to term premiums when uncertainty is low, especially for the 10-year yield. When we compare columns 2 and 4, we see that the response in the 10-year term premium is about twice as large as the response in the expected short rate. As expected, the difference between the magnitude of the reaction in the expected rate and term premium components is less marked for the 5-year yield, given that the term premium component is smaller for shorter-maturity Treasury securities. These results are consistent with those of Hanson and Stein (2015), who argue that a tightening surprise causes long-term yields to rise because yield-oriented investors sell long-term bonds, above and beyond what is required by the revelation of news about the expected path of policy. Similar to the results in Table 1, the higher monetary policy uncertainty, the smaller the responses—when uncertainty is at its 75th percentile, a 10 basis point tightening shock leads to a 2½ basis point increase in the 10-year term premium, which is about a basis point less than when uncertainty is at its median value (3½ basis points).

Table 2

Response of expected future nominal rates and term premiums to monetary policy surprises

	Dependent Variable			
	Expected rates		Term premium	
	5-year	10-year	5-year	10-year
	(1)	(2)	(3)	(4)
Coefficients				
Δmp_d	0.419***	0.408***	0.643***	0.789***
	(3.16)	(3.61)	(4.32)	(4.17)
Δmp_d x $uncertainty_{d-1}$	- 0.025	-0.054	-0.154**	-0.205***
	(-0.61)	(-1.44)	(-2.54)	(-2.68)
Evaluation				
Low Uncertainty	0.394***	0.356***	0.495***	0.592***
(25th perc.)	(3.99)	(4.34)	(5.21)	(4.90)
Medium Uncertainty	0.365***	0.294***	0.318***	0.357***
(50th perc.)	(5.29)	(5.39)	(6.62)	(6.02)
High Uncertainty	0.353***	0.269***	0.245***	0.260***
(75th perc.)	(5.53)	(5.37)	(5.05)	(4.44)
Observations	221	221	221	221
R-squared	0.31	0.29	0.23	0.21

NOTE: Reported coefficients denote the two-day response, around FOMC dates, of future expected rates and term premiums for nominal U.S. Treasury yields (with five- and ten- year maturity) to monetary policy surprises for various levels of monetary policy uncertainty. Expected rates ad term premiums are estimated using the Kim and Wright (2005) model. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample period is July 1991 to December 2017. ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

6. Robustness

To assess the robustness of our results in Table 1 and 2, this section discusses a series of alternative empirical tests, the results of which are reported in the Appendix.

Table A0 shows how our benchmark results for TIPS yields vary across sample periods. In our main regressions, the sample period starts in May 1999 because this is the first month in which prices of TIPS securities become reliable enough to estimate a real yield curve from, and because this is the first year the FOMC started releasing a post-meeting statement at each meeting regardless of the policy action taken. The first two columns of Tab A0 replicate our main results for TIPS yields from Table 1. The remaining four columns assess whether our main results are sensitive to the inclusion of the pre-zero lower bound period, when monetary policy uncertainty was particularly pronounced. As shown, our full-sample results for real yields hold in both the pre- and post-crisis sample and hence our results are not sensitive to dropping FOMCs dates that were characterized by an elevated level of uncertainty about the path of monetary policy. The reaction in real yields to monetary policy surprises is notable larger in the post-crisis sample, similar as for example reported in Gilchrist, Lopez-Salido and Zakrajsek (2015).

Table A1 uses instantaneous forward nominal and real rates, ending 5 and 10 years ahead, as the dependent variable. As shown in the table, the reaction of forward rates to monetary policy surprises mostly follows the same pattern as we documented for yields in Table 1: nominal and real forwards rates generally increase following monetary policy surprises, but the increase is muted when the one-year ahead measure of monetary policy is higher.

Table A2 uses a different time window to measure reactions in nominal and real yields to monetary policy surprises. In our baseline specification we use two-day changes in 5- and 10-year yields around an FOMC meeting to account for the possibility that the full reaction of longer-term yields to an FOMC announcement may not be instantaneous (as documented, for example, by Gűrkaynak, Sack, and Swanson, 2005). As shown in the table, our main results remain qualitatively and quantitatively similar if we instead use 60-minute changes in 5- and 10-year yields around FOMC announcements.

Finally, Table A3 assesses the robustness of our main results for TIPS yields to three alternative measures of monetary policy surprises. In the first two columns, the policy surprise is computed using the change in the 2-year Treasury yields in a narrower 30-minute window around FOMC announcements, as opposed to the 60-minute windows in our baseline specification. In the third and fourth columns, we instead use a wider 1-day event window. Finally, in the last two columns we use the monetary policy surprise of Nakamura and Steinsson (2018), which is based on 30-minute windows surrounding FOMC announcements but uses the first principle component derived from changes in interest rates at maturities of up to 1 year. In all instances, our main findings that the response of medium and long-term Treasury yields to monetary policy surprises is muted during periods of high monetary policy uncertainty continue to hold.

7. Primary Dealers' and Investors' Positions in Interest Rates

To explain the above findings, we study how net positions of investors in interest rate markets change in response to monetary policy surprises.

We begin with primary dealers, as they play a predominant role in the U.S. Treasury market. Fleming, Keane, and Schaumburg (2016) and Brain et al (2018), for example, estimate that primary dealers are the largest participants in the overall Treasury cash market, accounting for roughly 50 percent of its trading activity's share.

We use a measure of risk-taking by primary dealers in U.S. Treasury securities: changes in the duration-weighted net position.[14] These capture the directional exposure of primary dealers in U.S. Treasury cash securities and forward contracts, being equal to the difference between long and short positions, weighted for the duration of the position, in order to capture the different degrees of term risk. In particular, we focus on aggregate duration-weighted net positions for the maturity buckets 0-3, 3-6, 6-11, and 11-30 years, which we normalize by either gross (long plus short) positions or by the number of transactions, and which are available weekly (every Wednesday).

We use these data to test our hypothesis that when uncertainty is low, dealers are positioned more aggressively in interest rate markets and find themselves having to adjust their exposures substantially when a monetary policy surprise occurs.

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[14] The net position data is available for 23 primary dealers, which can be found at https://www.newyorkfed.org/markets/primarydealers.html.

To do so, we use the same regression framework employed earlier, but now by replacing the earlier dependent variables with the 5-(business-)day change around the day of a monetary policy announcement in the average dealer's net position in Treasury securities.

Table 3

Response of primary dealers' net U.S. Treasury positions to monetary policy surprises

	Dependent Variable	
	ΔNet dealer position (norm. by gross positions)	ΔNet dealer position (norm. by transactions)
	(1)	(2)
Coefficients		
Δmp_d	-0.247***	-0.299***
	(-4.48)	(-3.18)
Δmp_d x $uncertainty_{d-1}$	0.131***	0.156***
	(4.45)	(3.07)
Evaluation		
Low Uncertainty	-0.147***	-0.180***
(25th perc.)	(-4.06)	(-2.84)
Medium Uncertainty	-0.101***	-0.125***
(50th perc.)	(-3.45)	(-2.37)
High Uncertainty	0.049	0.054
(75th perc.)	(1.66)	-0.94
Observations	129	129
R-squared	0.20	0.13

NOTE: Reported coefficients denote the five-day changes, around FOMC dates, of primary dealers' duration-weighted net positions to 0-3 year, 3-6 year, 6-11 year, and 11-30 year U.S. Treasury cash and futures securities (reported by FRBNY) normalized by gross positions (column 1) or transactions (column 2) to monetary policy surprises for various levels of monetary policy uncertainty. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample period is January 2002 to December 2017. ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

If our hypothesis is valid, a positive monetary surprise should be associated with a negative change in net positions as dealers pull back their duration exposures. This reaction should be higher when policy uncertainty is low. Table 3 shows that this is indeed the case. As shown in the second column, when policy uncertainty is at its 25^{th} percentile, a 10 basis point tightening surprise leads to a 1.8 percentage point decline in the average net position (as a fraction of transactions) but this decline falls to 1.2 percentage points as policy uncertainty increases towards its median value, and becomes insignificant when policy uncertainty is at its 75^{th} percentile. The results for an alternative normalization scheme using gross positions (column 1) shows a similar pattern.

While primary dealers are important players, they are not the only investors in the interest rate markets. To provide further support to the mechanism that investors are positioned more aggressively in interest rate markets when uncertainty is low, we study whether this mechanism is also valid for speculators, such as hedge funds and asset managers. To do so, we replace the dependent variable in the regressions above with CFTC speculative positioning, a proxy for the risk-taking of these investors in interest rate markets.

Table 4 shows the results for two alternative measures of speculative positioning in the Treasury market: the duration-weighted number of net long Treasury futures contracts for the 2-, 5-, and 10-year maturities, normalized by either gross positions or open interest. These data are available weekly (every Tuesday) from the CFTC. As shown, when uncertainty is at its 25^{th} percentile, a 10 basis point monetary tightening surprise is associated with a reduction of net long positions of roughly 4 percentage points as a fraction of gross positions and a 1 percentage point reduction as a fraction of open interest. Both effects become insignificant and disappear when uncertainty is at its 75^{th} percentile, suggesting that the risk-taking mechanism is also valid for investors other than primary dealers.

8. Conclusions

In this paper we provide evidence that medium- and long-term interest rates respond more to monetary policy surprises when the prevailing level of uncertainty about the path of monetary

Table 4

Response of changes in CFTC speculative futures positions to monetary policy surprises

	Dependent Variable	
	ΔNet spec position (norm. by gross positions)	ΔNet spec position (norm. by open interest)
	(1)	(2)
Coefficients		
Δmp_d	-0.757**	-0.165**
	(-2.38)	(-2.32)
Δmp_d x $uncertainty_{d-1}$	0.364***	0.080**
	(2.73)	(2.58)
Evaluation		
Low Uncertainty	-0.474**	-0.103**
(25th perc.)	(-2.18)	(-2.14)
Medium Uncertainty	-0.087	-0.019
(50th perc.)	(-0.94)	(-0.88)
High Uncertainty	0.101	0.022
(75th perc.)	(1.59)	(1.25)
Observations	128	128
R-squared	0.09	0.07

NOTE: Reported coefficients denote the five-day changes, around FOMC dates, of speculative investors' duration-weighted sum of the number of net non-commercial futures and options futures contracts outstanding for 2-year, 5-year, and 10-year U.S. Treasury securities (reported by CTFC) normalized by gross positions (column 1) or open interest (column 2) to monetary policy surprises for various levels of monetary policy uncertainty. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty--prevailing the day before FOMC dates--for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample period is January 2002 to December 2017. ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

policy is low. This evidence points to a non-trivial tradeoff for central banks' communications. On the one hand, clear communication enhances policy effectiveness by moving interest rates in a way the central bank intends. On the other hand, communications aimed to cement market expectations about the future path of policy may lead to large changes in long-term interest rates, and thus financial conditions, when a policy surprise materializes, upending the central bank's intentions.

References

Adrian, T., R. K. Crump, and E. Moench (2013), "Pricing the Term Structure with Linear Regressions", *Journal of Financial Economics*, Vol. 110 (No. 1), pp. 110-138.

Altavilla, C., D. Giannone, and M. Modugno (2017), "Low frequency effects of macroeconomic news on government bond yields," *Journal of Monetary Economics*, Vol. 92(C), pp. 31-46.

Baker, S.R., N. Bloom, and S. Davis (2016), "Measuring Economic Policy Uncertainty", *Quarterly Journal of Economics,* Vol. 131. (No. 4), pp. 1593-1636.

Bloom, N (2014), "Fluctuations in Uncertainty", *Journal of Economic Perspectives*, Vol. 28 (No. 2), pp. 153-176.

Brain, D, M. De Pooter, D. Dobrev, M. Fleming, P. Johansson, C. Jones, M. Puglia, F. Keane, L. Reiderman, T., and O. Shachar (2018). "Unlocking the Treasury Market through TRACE ," *FEDS Notes. Washington: Board of Governors of the Federal Reserve System*, September 28, 2018, https://doi.org/10.17016/2380-7172.2251.

Campbell, J. R., C. L. Evans, J. D. Fisher, and A. Justiniano (2012), "Macroeconomic Effects of Federal Reserve Forward Guidance," *Brookings Papers on Economic Activity Spring*, pp. 1-54.

Fleming, M., F. Keane, and E. Schaumburg (2016), "Primary Dealer Participation in the Secondary U.S. Treasury Market", *Liberty Street Economics*, Federal Reserve Bank of New York, February 12, 2016.

Gertler, M., P. Karadi (2015), "Monetary Policy Surprises, Credit Costs, and Economic Activity", *American Economic Journal: Macroeconomics*, Vol 7. (No. 1), pp. 44-76.

Gilchrist, S., D. López-Salido, and E. Zakrajšek (2015), "Monetary Policy and Real Borrowing Costs at the Zero Lower Bound", *American Economic Journal: Macroeconomics*, Vol 7. (No. 1), pp. 77-109.

Gűrkaynak, R. S., B. Sack, and E. T. Swanson (2005), "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements", *International Journal of Central Banking*, Vol. 1 (No. 1), pp. 55-93.

Gűrkaynak, R. S., B. Sack, and J. H. Wright (2007), "The U.S. Treasury Yield Curve: 1961 to the Present", *Journal of Monetary Economics*, Vol. 54 (No. 8), pp. 2291-2304.

Gűrkaynak, R. S., B. Sack, and J. H. Wright (2010), "The TIPS Yield Curve and Inflation Compensation", *American Economic Journal: Macroeconomics*, Vol. 2 (No. 1), pp. 70-92.

Hanson, S. E. and J. C. Stein (2015), "Monetary policy and long-term real rates", *Journal of Financial Economics*, Vol. 115 (No. 3), pp. 429-448.

Iercosan, D., A. Kumbhat, M. Ng, and J. Wu (2017), "Trading activities at systematically important banks, part 1: recent trends in trading performance," *FEDS Notes*, *Washington: Board of Governors of the Federal Reserve System*, July 10, 2017, https://doi.org/10.17016/2380-7172.2023.

Kim, D. and J. H. Wright (2005), "An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates", *FEDS Working Papers* 2005-33.

Mallaby, S. (2017), "Why the Fed Should Surprise Us More", *Wall Street Journal*, June 23, 2017.

Nakamura, E. and J. Steinsson (2018), "High Frequency Identification of Monetary Non-Neutrality: The Information Effect," *Quarterly Journal of Economics*, Vol. 133 (No. 3), pp. 1282-1330.

Stein, J. C. (2014), "Challenges for Monetary Policy Communications", *speech delivered at the Money Marketers of New York University, New York, May 6.*

Svensson, L. E. O. (1994), "Estimating and Interpreting Forward Interest Rates: Sweden 1992-1994", *National Bureau of Economic Research Working Paper*, No. 4871

Swanson, E. T. (2006), "Have Increases in Federal Reserve Transparency Improved Private Sector Interest Rate Forecasts?" *Journal of Money, Credit, and Banking*, Vol. 38 (No. 3), pp. 791–819.

Swanson, E. T., and J. Williams (2014). "Measuring the Effect of the Zero Lower Bound on Medium- and Longer-Term Interest Rates," *American Economic Review*, Vol. 104 (No. 10), pp. 3154–3185.

Taylor, J. B. (1993), "Discretion versus Policy Rules in Practice', *Carnegie-Rochester Conference Series on Public Policy*, Vol. 39, pp. 195-214.

Taylor, J. B. (1999), "A Historical Analysis of Monetary Policy Rules" in *Monetary Policy Rules, Chicago: University of Chicago Press, John B. Taylor, ed.*, pp. 319-41.

Wynne, M. A. (2013), "A Short History of FOMC Communications", *Federal Reserve Bank of Dallas Economic Letters*, Vol. 8 (No. 8).

APPENDIX: Robustness Results

Table A0

Response of U.S. Treasury real yields to monetary policy surprises on different sample periods

	Sample period: 1999-2017		Sample period: 1999-2007		Sample period: 2008-2017	
	Dependent Variable		Dependent Variable		Dependent Variable	
	TIPS Yields		TIPS Yields		TIPS Yields	
	5-year	10-year	5-year	10-year	5-year	10-year
	(1)	(2)	(3)	(4)	(5)	(6)
Coefficients						
Δmp_d	3.422***	2.814***	3.919***	3.582***	3.686***	2.449***
	(7.03)	(5.54)	(4.59)	(4.08)	(5.28)	(3.11)
Δmp_d x $uncertainty_{d-1}$	-1.202***	-0.999***	-1.400***	-1.311***	-1.814**	-1.067
	(-5.98)	(-4.74)	(-4.01)	(-3.60)	(-2.57)	(-1.34)
Evaluation						
Low Uncertainty	2.432***	1.992***	1.180***	1.018***	3.089***	2.097***
(25th perc.)	(7.42)	(5.89)	(5.92)	(5.48)	(6.40)	(3.88)
Medium Uncertainty	1.164***	0.938***	0.677***	0.548***	2.348***	1.661***
(50th perc.)	(7.98)	(6.87)	(5.57)	(5.70)	(9.10)	(6.03)
High Uncertainty	0.556***	0.433***	0.329**	0.221**	2.103***	1.517***
(75th perc.)	(5.10)	(4.92)	(2.60)	(2.04)	(9.59)	(6.70)
Observations	158	158	94	94	64	64
R-squared	0.46	0.40	0.48	0.45	0.50	0.40

NOTE: Reported coefficients denote the two-day response, around FOMC dates, of real U.S. Treasury yields (with five- and ten-year maturity) to monetary policy surprises for various levels of monetary policy uncertainty. Columns 1 to 2 use FOMC dates between 1999 and 2017, while columns 3 to 6 split the sample in 1999-2007 and 2008-2017. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

Table A1
Response of U.S. Treasury instantaneous nominal and real forward rates to monetary policy surprises

	Dependent Variable			
	Nominal instantaneous forward ending in		TIPS instantaneous forward ending in	
	5-year	10-year	5-year	10-year
	(1)	(2)	(3)	(4)
Coefficients				
Δmp_d	1.894***	0.758	3.325***	1.246*
	(3.42)	(1.26)	(4.73)	(1.87)
Δmp_d x $uncertainty_{d-1}$	-0.531**	-0.193	-1.110***	-0.496*
	(-2.57)	(-0.84)	(-3.66)	(-1.76)
Evaluation				
Low Uncertainty	1.382***	0.572	2.412***	0.838*
(25th perc.)	(3.79)	(1.47)	(5.18)	(1.90)
Medium Uncertainty	0.773***	0.351**	1.241***	0.314*
(50th perc.)	(4.51)	(2.03)	(5.99)	(1.73)
High Uncertainty	0.522***	0.260*	0.679***	0.063
(75th perc.)	(3.74)	(1.80)	(3.79)	(0.46)
Observations	221	221	158	158
R-squared	0.16	0.05	0.30	0.08

NOTE: Reported coefficients denote the two-day response, around FOMC dates, of instantaneous forward nominal and real U.S. Treasury rates ending in 5 and 10 years ahead to monetary policy surprises, for various levels of monetary policy uncertainty. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample period are July 1991 to December 2017 (nominal) and January 1999 to December 2017 (TIPS). ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

Table A2

60-minute changes of U.S. Treasury nominal and real yields around FOMC announcements to monetary policy surprises

	Dependent Variable			
	Nominal Yields		TIPS Yields	
	5-year	10-year	5-year	10-year
	(1)	(2)	(3)	(4)
Coefficients				
Δmp_d	1.371***	0.960***	2.079***	1.485***
	(6.52)	(3.47)	(7.79)	(4.03)
Δmp_d x $uncertainty_{d-1}$	-0.184**	-0.129	-0.533***	-0.385**
	(-2.22)	(-1.21)	(-4.63)	(-2.53)
Evaluation				
Low Uncertainty	1.193***	0.835***	1.744***	1.193***
(25th perc.)	(8.96)	(4.71)	(8.87)	(4.69)
Medium Uncertainty	0.980***	0.686***	1.553***	1.008***
(50th perc.)	(17.72)	(9.43)	(9.84)	(5.54)
High Uncertainty	0.896***	0.627***	1.036***	0.673***
(75th perc.)	(18.53)	(10.92)	(15.39)	(11.46)
Observations	221	221	116	131
R-squared	0.84	0.60	0.84	0.62

NOTE: Reported coefficients denote the two-day response, around FOMC dates, of instantaneous forward nominal and real U.S. Treasury rates ending in 5 and 10 years ahead to monetary policy surprises, for various levels of monetary policy uncertainty. Monetary policy surprises are proxied by the 60-minute change in the two-year nominal yield surrounding (15 minutes prior and 45 minutes after) FOMC announcements. Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample period are July 1991 to December 2017 (nominal), March 2004 to December 2017 (5-year TIPS), May 2002 to December 2017 (10-year TIPS). ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.

Table A3

Response of U.S. Treasury real yields to monetary policy surprises -- using alternative measure of policy surprises

	30-minute MP shocks		1-day MP shocks		Nakamura-Steinsson shocks	
	Dependent Variable		Dependent Variable		Dependent Variable	
	TIPS Yields		TIPS Yields		TIPS Yields	
	5-year	10-year	5-year	10-year	5-year	10-year
	(1)	(2)	(3)	(4)	(3)	(4)
Coefficients						
Δmp_d	3.613***	2.889***	1.250***	1.197***	5.145***	3.731***
	(5.75)	(5.02)	(10.11)	(10.41)	(4.27)	(3.16)
Δmp_d x $uncertainty_{d-1}$	-1.249***	-1.025***	-0.274***	-0.309***	-1.925***	-1.426***
	(-4.90)	(-4.35)	(-5.19)	(-6.48)	(-3.74)	(-2.82)
Evaluation						
Low Uncertainty	2.585***	2.045***	1.030***	0.948***	4.060***	2.927***
(25th perc.)	(6.05)	(5.27)	(12.38)	(12.16)	(4.43)	(3.25)
Medium Uncertainty	1.268***	0.965***	0.758***	0.640***	1.379***	0.941***
(50th perc.)	(6.37)	(5.62)	(19.20)	(17.40)	(5.44)	(3.83)
High Uncertainty	0.635***	0.446***	0.610***	0.474***	0.501***	0.291*
(75th perc.)	(4.26)	(3.62)	(19.78)	(18.19)	(2.74)	(1.68)
Observations	158	158	158	158	104	104
R-squared	0.39	0.32	0.20	0.19	0.44	0.21

NOTE: Reported coefficients denote the two-day response, around FOMC dates, of real U.S. Treasury yields (with five- and ten-year maturity) to monetary policy surprises for various levels of monetary policy uncertainty. Monetary policy surprises are proxied by (i) the 30-minute change in the two-year nominal yield surrounding (10 minutes prior and 20 minutes after) FOMC announcements shown in columns 1-2, (ii) the 1-day change in the two-year nominal yield from COB the day before the FOMC announcement to COB the day of the announcement shown in columns 3-4, and (iii) surprises proxied by the Nakamura and Steinsson (2018) measure, which is the 30-minute change surrounding FOMC announcements (15 minutes prior and 15 minutes after) of the first principle component of interest rates at different maturities spanning the first year of the term structure (columns 5-6). Monetary policy uncertainty refers to the uncertainty, prevailing the day before FOMC dates, for the federal funds rate one-year ahead as implied by derivative prices. Low/Medium/High uncertainty corresponds to the lower, median and upper quartile of the monetary policy uncertainty historical distribution. Sample periods are January 1999 to December 2017 (columns 1-4) and January 2000 - March 2014 (columns 5-6). ***, ** and * indicate statistical significance at 1%, 5%, and 10% level, respectively. *t*-ratios, based on robust standard errors, are shown in parenthesis below the estimated coefficients. Coefficients adjusted to represent 100 basis point monetary policy shock.