The Fed and the Stock Market: A Tale of Sentiment States

Haifeng Guo* Chi-Hsiou D. Hung† Alexandros Kontonikas‡

March 30, 2019

Abstract

We show that the state of investor sentiment strongly affects the transmission of conventional and non-convectional monetary policy to the stock market. During the periods when sentiment wanes, our event study estimates translate to a 2% stock market excess return on the day of a hypothetical unexpected cut of 25 basis points in the Federal funds rate. The pre-FOMC announcement drift, embargo period news leakage or economic recessions do not drive the effects. Further, the impact of path surprises is significant only when sentiment declines. The stock market also responds to announcements of central bank liquidity swaps. In contrast, during periods of optimism build-up, the stock market response is insignificant.

Keywords: Investor Sentiment States, Monetary Policy, Stock Market Returns, Policy Asymmetry.
JEL classification: G11, G12, G14, E44, E52.

*Durham University Business School, Durham University, Durham, UK, haifeng.guo@durham.ac.uk
†Adam Smith Business School, University of Glasgow, Glasgow, G12 8QQ, UK, chi-hsiou.hung@glasgow.ac.uk
‡Essex Business School, University of Essex, Colchester, CO4 3SQ, UK, a.kontonikas@essex.ac.uk

We thank Panayiotis Andreou, Malcolm Baker, Jerry Coakley, Chris Florackis, Alexandros Kostakis, Alexander Kurov, Paulo Maio, Alberto Montagnoli, Kjell Nyborg, Stefan Ruenzi, Antonios Siganos, Evangelos Vagenas-Nanos, Patrick Verwijmeren, Nikos Vlastakis, conference participants at the 2018 Financial Management Association Conference, the 2018 Financial Stability and Banking Conference, the 2017 Financial Management Association Asian Conference, the 2017 European Financial Management Association Conference, the 7th International Conference of the Financial Engineering and Banking Society, the 2017 World Banking and Finance Symposium, the 2017 Behavioural Finance Working Group Conference, the 2017 Conference on the Theories and Practises of Securities and Financial Markets, and seminar participants at National Bank of Slovakia, Middlesex University, University of Essex, University of Glasgow, Nankai University and National Cheng Kung University for useful comments and suggestions.

1 Introduction

"*Animal spirits, sentiment, psychology, whatever you want to call it, was central to the economic and financial story...*" (B. Bernanke, 2015)

Investor sentiment refers to investors' biased beliefs in asset valuation and the behavioral finance literature has established that sentiment affects stock prices (Lee, Shleifer, and Thaler, 1991; Baker and Wurgler, 2006; Stambaugh, Yu, and Yuan, 2014). In the presence of short-sales constraints (Miller, 1977) and, more generally, the limits of arbitrage (Shleifer and Vishny, 1997), the build-up of optimism when sentiment grows leads to an extended period of market overvaluation (De Long et al., 1990). The subsequent correction of overpricing is associated with lower future stock returns (Baker and Wurgler, 2006; Stambaugh, Yu, and Yuan, 2012; Huang et al., 2015). The time-series variation in mispricing and sentiment implies that the impact of monetary policy shifts on the stock market may vary over time. An important question we ask is whether the price response of the stock market to monetary policy news depends on the state of investor sentiment.

In this paper, we analyze the role of investor sentiment in the transmission of the Federal Reserve's monetary policy decisions on the aggregate stock market price. Prior research has documented a significant stock price response to monetary policy shifts (Bernanke and Kuttner, 2005; Maio, 2014; Ozdagli, 2017). These studies, however, do not consider the role of sentiment on stock prices and interpret their findings within the efficient markets framework.[1]

This study is the first to show that the stock market reaction to monetary policy news depends on the state of sentiment. Using both intraday and daily data, we find that the state of investor sentiment strongly affects the stock market response to monetary policy shocks. The results remain strong and consistent from a host of robustness checks. Our findings have important implications for the policy decision consideration of the Federal

[1]The dividend discount model of stock valuation suggests that shifts in monetary policy can affect stock prices through changes in the rates that market participants use to discount future cash flows, and through changes in the expected cash flows. Using a return variance decomposition framework, Bernanke and Kuttner (2005) demonstrate the importance of revisions in expected returns, that is, discount rate news, in explaining the impact of monetary policy shocks on the stock market.

Open Market Committee (FOMC) and also for market participants.[2]

We classify sentiment states using two approaches. The first approach follows the existing literature and uses a classification based on the *level* of sentiment (Baker and Wurgler, 2006; Yu and Yuan, 2011; Chung, Hung, and Yeh, 2012). This classification intends to capture the effect of monetary policy news following periods of high versus low sentiment. The second approach is novel and focuses on *changes* in sentiment, which identifies periods of optimism build-up versus periods of waning sentiment. The two approaches are inherently related given the mean-reverting property of sentiment (Baker and Wurgler, 2006; Yu and Yuan, 2011; Chung, Hung, and Yeh, 2012). We employ three widely adopted measures of sentiment: the University of Michigan Consumer Sentiment Index, the U.S. Consumer Confidence Index and the Sentiment Index constructed by Baker and Wurgler (2006). We remove the effects of business cycle variation by orthogonalizing each sentiment measure to a set of macroeconomic variables.

We use an event study methodology to estimate the stock market reaction to monetary policy shocks conditional on sentiment states. Our sample covers the period from June 1989 to October 2014, hence including the pre-crisis period, the financial crisis of 2007-2008 and its aftermath. We first analyze conventional monetary policy shocks, which are measured through unexpected changes in the Federal funds rate (FFR) using the methodology of Kuttner (2001). This analysis concentrates on the sample period up to the end of 2008 when, following several rate cuts, the FFR reached the zero lower bound (ZLB) and the Fed turned to non-conventional monetary policy. In the ZLB era the volatility of FFR shocks is essentially zero. We then analyze non-conventional policy shocks. The Fed implements "forward guidance" to influence the path of future short-term rates through various communication channels. As a proxy for news related to forward guidance, we calculate path surprises following the approach of Gürkaynak, Sack, and Swanson (2005). We further analyze the impact of announcements related to Large-Scale Asset Purchases (LSAPs) and the provision of liquidity facilities, which change the size

[2]Because the policy effect on the economy is indirect and delayed, policymakers closely monitor the immediate stock market response to monetary policy news. The financial press also widely assigns a large weight on the Fed's policy stance to explain stock price changes.

and composition of the Fed's balance sheet.

We conjecture that the stock market reacts significantly to news arising from the Fed only during sentiment-waning episodes. Following high investor sentiment, overpricing tends to be corrected as economic fundamentals are revealed and stock market returns are low (Huang et al., 2015), with varying degrees of pricing correction across different categories of stocks (Baker and Wurgler, 2006; Baker and Wurgler, 2007; Stambaugh, Yu, and Yuan, 2012). Since most investors have long positions (Gervais and Odean, 2001), the pricing correction generates investment losses following high sentiment. The monetary losses make investors anxious and fearful. According to the psychology literature, anxiety and fear are associated with a greater sense of uncertainty (Ortony, Clore, and Collins, 1990; Park and Banaji, 2000; Lerner and Keltner, 2000). We argue that investors exhibit greater sensitivity to news during sentiment downturns. Our analyses show that the effect during sentiment downturns is distinct from that of economic recessions analyzed by Garcia (2013).

Thus, we hypothesize that investors will be more sensitive to monetary policy shocks during sentiment-waning phases. Especially more so, when faced with expansionary monetary policy shocks that may alleviate, at least temporarily, the anxiety and fear of investors. Our evidence (in Table 7), which shows that the arrival of expansionary monetary policy shocks reduces the variance risk premium when sentiment wanes, is consistent with this notion of fear alleviation. When sentiment reaches a low level, the extent of mispricing is small (Miller, 1977; Yu and Yuan, 2011; Stambaugh, Yu, and Yuan, 2012). Because sentimental investors who lost substantial capitals are driven to the margin or out of the market, we expect that the market reaction to the Fed's actions to be relatively mute.

On the other hand, during optimism build-up periods, investors' demand shocks rise.[3] Due to short-sales constraints (Miller, 1977; Lamont and Stein, 2004) and, more broadly, the limits of arbitrage (De Long et al., 1990; Shleifer and Vishny, 1997), bearish investors,

[3]DeVault, Sias, and Starks (2018) argue that it is institutional investors' demands, rather than individuals' demands that rise. In contrast, a long standing literature shows that trading activity of noise traders rises (Grinblatt and Keloharju, 2001; Cen, Lu, and Yang, 2013; Antoniou, Doukas, and Subrahmanyam, 2015; Yuan, 2015) and that these investors are inclined to engage in heuristic processing of information (Shleifer, 2000; Tiedens and Linton, 2001) and trade in concert (Kumar and Lee, 2006).

who believe that stocks are overvalued, sit on the sidelines, instead of selling short stocks. Thus, investors with the most optimistic views push prices far away from fundamental values and hence, overprice stocks (Stambaugh et al., 2012).[4]

We argue that the overvaluation of stocks attenuates the impact of monetary policy news, which arrives at times when investors have already pushed prices far away from fundamental values, and hence, the marginal price impact of monetary policy news is limited. This is consistent with the psychological evidence of diminishing sensitivity of the prospect theory (Kahneman, 1979; Tversky and Kahneman, 1992; Lian, Ma, and Wang, 2018), which demonstrates that investors' sensitivity diminishes following gains because marginal utility gain is smaller.

For conventional monetary policy, we find that, first, the impact of policy shocks on the stock market concentrates on sentiment-waning episodes when sentiment starts high at the beginning of the year and then falls. In our pre-ZLB sample (June 1989 - December 2008), 47% (85 out of 180) of the FOMC meetings occurred in years of waning sentiment. During these periods, our event study estimates translate to a 0.4% (2%) stock market return in excess of the T-bill rate on the day of an unexpected cut of 5 (25) basis points in the FFR. In sharp contrast, during periods when sentiment starts low and optimism grows afterwards, the stock market does not show a significant price reaction to monetary policy shocks.

Second, we use intraday data to demonstrate that our results are not confounded by the pre-FOMC announcement drift (Lucca and Moench, 2015) or by leakage of news during the embargo period (Bernile, Hu, and Tang, 2016; Kurov et al., 2017). Third, we show that the effect of sentiment is not driven by economic recessions. In fact, only outside recessions does the stock market show a significant response, both statistically and economically, to FFR shocks during sentiment waning periods. We also find that the sentiment-dependent market response to the monetary policy news is stronger during monetary policy easing cycles.

Fourth, we find that the stock market impact of monetary policy shocks is charac-

[4]Essentially, investors assign excessively optimistic valuations, either by overestimating the size of future cash flows or by underestimating risk (Mian and Sankaraguruswamy, 2012; Kaplanski et al., 2015)

terized by sign asymmetry. The market response following periods of high sentiment is significant for expansionary FFR surprises, but not for tightening surprises. This evidence is consistent with our argument that the Fed's expansionary shocks alleviate the anxiety and fear of investors, at least temporarily, during sentiment waning episodes. Fifth, we are mindful to minimize the possibility of erogeneity arising from reverse feedback in which the Fed may be responding to market developments in line with the "Fed put" story (Cieslak and Vissing-Jorgensen, 2017). To address this concern, we remove unscheduled meetings, those occasions where the Fed is likely to provide monetary stimulus in response to market turmoil. We also use the latent variable approach of Thornton (2014) to address the possibility of joint-response by the market and the Fed to economic news. Our evidence indicates that our findings are robust to these considerations. Finally, we show that effect of FFR surprises is predominantly contemporaneous and displays only very short-run persistence.

The magnitude of the financial crisis that commenced in late 2007 was unprecedented, as compared with previous episodes of financial turmoil. It greatly affected financial markets, the real economy, and the conduct of monetary policy.[5] Sentiment measures reached historical lows at the peak of the crisis, reflecting the extreme uncertainty, fear and anxiety that gripped investors, and remain subdued, relative to the past, until the end of our sample. For non-conventional policy, the feature of low sentiment during the ZLB period restricts our analysis to states based on the change in sentiment. In our ZLB sample (January 2009 - October 2014), 34% (16 out of 47) of the FOMC meetings occurred when sentiment was declining. We find that the impact of path surprises is significant only during such periods. In addition, the stock market reacted positively to announcements related to the establishment of central bank liquidity swaps, albeit not to LSAPs announcements, during sentiment declines.

One might ponder an alternative explanation based on investors' attention.[6] Previous

[5]The recession that accompanied the burst of the "dot-com" bubble in early 2000s was shallower relative to the one associated with the recent crisis. The VIX also peaked at much higher peak level in autumn of 2008.

[6]Because attention is a scarce cognitive resource, investors have limited attention (Da, Engelberg, and Gao, 2011).

studies show that investors' attention to market-wide developments is likely to be stronger during economic downturns (Peng and Xiong, 2006), which could imply a stronger response to monetary policy news. As we demonstrate, however, that sentiment waning occurs not only in periods of economic recessions but also during expansions, which is in favor of our sentiment-based explanation.

Our findings supports a behavioral interpretation and are not easy to fit into a rational framework. For example, the positive response to expansionary news could be interpreted within the dividend discount model or other macroeconomic-based models that propose a risk factor related to the stance of monetary policy (Balvers and Huang, 2009; Lioui and Maio, 2014).[7] These models, however, cannot explain why only expansionary news matter, and more broadly, why significant price reactions only occur during sentiment waning states. Moreover, empirical evidence suggests that the Fed's interventions can also have a direct impact on sentiment (Lutz, 2015), especially during bear markets (Kurov, 2010). Thus, it is more natural to present our results using a behavioural viewpoint.

Our study contributes to the nascent line of work that seeks to incorporate findings from behavioural finance to examine the stock market reaction to news, as well as the established literature that studies the effects of the Fed's conventional and non-conventional policy actions on financial markets. We develop a new measure of sentiment states based on changes in sentiment and show that it reveals important information about the trading behaviour of investors during periods of sentiment adjustment. Hence, we extend the previous literature on the asset pricing implications of sentiment, which overlooks the dynamic behaviour of sentiment.

Our work is also related to the literature on state dependence in the relationship between stock market and monetary policy. Several studies consider business cycle effects and show that the stock market response is stronger during recessions (Basistha and Kurov, 2008; Perez-Quiros and Timmermann, 2000). Our analysis takes a new angle and focuses on sentiment states, which have small or zero correlation with the business cycle. Furthermore, sentiment waning is not solely associated with bear markets but also occur

[7]Rational explanations focus on the state of the economy and link time-varying expected returns to macroeconomic variables (Perez-Quiros and Timmermann, 2000; Chordia and Shivakumar, 2002.

during periods of bull markets. Hence, our analysis is distinct from previous studies that condition the stock market response to policy surprises on bull-bear regimes (Chen, 2007; Kurov, 2010).

We study market-wide news that stem from shifts in monetary policy on the aggregate market price. On the other hand, Mian and Sankaraguruswamy (2012) focus on firm-specific news (earnings surprises) and examine whether lagged sentiment affects stock price changes. They conclude that behavioral biases affect how accounting information is impounded into a firm's stock price. Rosen (2006) analyzes the impact of sentiment on the bidders' price reaction to merger announcements. Garcia (2013) and Cenesizoglu (2014) argue that investors' sensitivity to news is state dependent. In Garcia's (2013) analysis, however, this is related to the state of the business cycle, with the sensitivity to news being stronger during economic downturns. Similarly, in Cenesizoglu (2014) it is the underlying state of the economy that matters. Our study focuses on sentiment downturns that, as we argue above and our evidence suggests, are distinct from economic recessions.

Finally, a related strand of the literature tests pre-announcement effects on returns and/or order imbalance and volatility (Lucca and Moench, 2015; Bernile, Hu, and Tang, 2016; Kurov et al., 2017; Neuhierl and Weber, 2017; Cieslak et al., 2018). These studies do not account for the possible impact of sentiment states.

The rest of the paper proceeds as follows. Section 2 describes the data and variables that we employ in the empirical analysis. Section 3 presents evidence related to the role of investor sentiment in the transmission of monetary policy news to the stock market. Section 4 presents the results from various robustness checks. Finally, Section 5 concludes.

2 Data and sample

2.1 Monetary policy news

2.1.1 Target rate surprises

Before the recent financial crisis, Open Market Operations (OMOs) were the key policy tool that the Fed used to achieve its operating target for the FFR, which is the interest

rate on overnight loans of reserves between banks (Bernanke and Mihov, 1998; Romer and Romer, 2004). The ultimate goals of the Feb are maximum employment and price stability. OMOs involve buying or selling U.S. government securities (primarily Treasury bills) either outride or, more commonly through repurchase and sale-repurchase agreements. Monetary policy decisions are taken by the FOMC and implemented by the Open Market Trading Desk of the New York Fed. For example, to reduce the FFR, the Fed would buy securities, thereby adding to reserves in the banking system and reducing the need of banks to borrow reserves from each other.

Our full sample covers the period June 1989 - October 2014 and includes 228 FOMC meetings. Before 1994, there were no press releases regarding FOMC decisions and market participants had to infer whether the FOMC had taken a policy action from the signals provided by the size and type of OMOs in the days following each meeting. The dates provided by Kuttner (2003) are used to identify event dates prior to February 1994, while for the rest of the sample we use the FOMC meeting dates, obtained from the Fed's website: http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm. In a development that enhanced transparency, on February 1994 the Fed commenced the practice of issuing a statement on the day that the FOMC meeting is concluded to inform market participants about an interest rate change.[8]

Some of the FOMC meetings in our sample were unscheduled, taking place between the 8 regular meetings each year (listed in Table A2 of the Online Appendix). In total, 18 out of the 26 unscheduled meetings occurred before 1994, while the remaining ones are typically associated with episodes of financial turmoil in the post-1994 period. In the robustness checks, we show that our baseline results are not sensitive to the choice of using February 1994 as the start of the sample. In line with Bernanke and Kuttner (2005) and several other related studies, we exclude from the baseline estimation sample the unscheduled FOMC meeting that occurred in the first day of trading following the 11 September 2001 terrorist attack (17 September 2001). Additionally, we remove the most prominent outlier, as identified by the difference in the fits statistic of Welsch and Kuh

[8]See Table A1 in the Online Appendix for a list of key developments in the Fed's communication policy over time.

(1977), that corresponds to the unscheduled FOMC meeting on 22 January 2008.[9] We further analyze the role of unscheduled meetings in Section 3.2.4.

Using the methodology proposed by Kuttner (2001), we isolate the unexpected component of changes in the FFR (Δi_t^u) on day t in the month when the FOMC meeting takes place:

$$\Delta i_t^u = \frac{D}{D-t}(f_{m,t}^0 - f_{m,t-1}^0) \tag{1}$$

where $f_{m,t}^0$ is the current-month implied futures rate (100 minus the FFR futures contract price), and D is the number of days in the month.[10]

Essentially, this measure of monetary policy news captures revisions in expectations about the FFR using the price change in the 30-day Federal funds futures contract relative to the day preceding the policy action. These contracts are cash settled against the average daily effective FFR for the delivery month. Hence, the implied surprise is adjusted by a factor related to the number of days in the month affected by the policy change. Fed funds futures are commonly employed by both market participants and policymakers to gauge FFR expectations.[11]

FFR expectations embedded in futures contracts have some key advantages over alternative proxies, such as immunity to model selection issues (Kuttner, 2001). They tend to outperform forecasts based on sophisticated time-series models, monetary policy rules and forecasts obtained using other financial market instruments (Evans, 1998; Gürkaynak et al., 2007). Moreover, focusing on one-day changes in near-dated Fed funds futures on the day of a monetary policy announcement is important to "difference out" predictable risk premia (Piazzesi and Swanson, 2008). The emphasis on monetary policy surprises

[9] On 22 January 2008 the market declined by almost 1%, in spite of a massive FFR cut of 75 basis points, almost all of which was unexpected (see Table A2 in the Online Appendix). In a similar fashion, on 17 September 2001 stock prices fell despite a large FFR cut. In the robustness checks, we show that using an estimation method which is robust to the presence of outliers, the main results hold when the two aforementioned events are included in the estimation sample.

[10] Following Kuttner (2001), when the FOMC meeting falls on one of the last three days of the month, the unscaled change in the one-month futures rate ($f_{m,t}^1 - f_{m,t-1}^1$) is used to calculate the FFR surprise. Also, when the FOMC meeting occurs on the first day of the month, $f_{m-1,D}^1$, instead of $f_{m,t-1}^0$, is used to measure the surprise. The source of the futures data is Bloomberg, while the FFR data is obtained from the Federal Reserve Economic Database (FRED) maintained by the St. Louis Fed.

[11] For references to FFR futures by policymakers and the financial press, see, e.g., the 2005 Federal Reserve Monetary Policy Report to Congress (p.22), Bernanke (2015), and the Wall Street Journal (2 January 2019).

is in line with the idea that the market is not likely to react to anticipated actions since these should already be incorporated in stock prices prior to the FOMC announcement (Ozdagli, 2017). The futures market-based proxy of policy news has been extensively used in previous event studies that analyze the response of stock prices to monetary policy shifts (Bernanke and Kuttner, 2005; Kontonikas, MacDonald, and Saggu, 2013; Ozdagli, 2017).

Figure 1 plots actual and unexpected changes in the target FFR on FOMC meeting dates. It shows that large expansionary monetary policy shocks, as reflected in unexpected declines in the FFR, typically occur during, or near, periods of economic slowdown. Table 1 reports that the average FFR change is equal to -0.04%, ranging from a minimum of -0.75% to a maximum of 0.75%. There are 82 FOMC meetings that are associated with FFR changes, 51 of which are of expansionary nature ($\Delta i < 0$), while 31 are contractionary ($\Delta i > 0$). On average, target rate surprises are expansionary with a mean of -0.02%. There are 88 instances of expansionary shocks, 30 of which correspond to an unexpected FFR decline of 10 basis points or more. In October 2008, in the aftermath of the Lehman Brother's collapse, the Fed reduced the target FFR from 2% to 1%. This was followed by another major cut in the FFR at the FOMC meeting on 16 December 2008, from 1% to the range of 0%–0.25%. Since then and until the end of the sample period, there are no further rate changes and the volatility of FFR shocks dies out. Therefore, our estimation for the impact of FFR shocks on the stock market focuses on the period before the ZLB (June 1989 - December 2008).

2.1.2 Path surprises

In order to alleviate the constraint to monetary stimulus that the ZLB posed, the Fed provided frequent assurances about its intention to keep the policy rate at near zero in the future, the so-called forward guidance (Bernanke, 2013; Doh and Connolly, 2013).[12] Generally, forward guidance implies that the central bank attempts to influence the path of future short-term rates through communication. Forward guidance has been intensively

[12]The Fed's forward guidance during the ZLB evolved from qualitative, to date-based, and finally to threshold-based. See Table A1 in the Online Appendix for more details.

used since 2009, but it has long been a part of the Fed's toolkit. Its origins can be traced back to the developments in the mid-to-late 1990s during the Greenspan era (Greenspan, 2008; Bernanke, 2015). Over time, the idea that monetary policy is, at least partly, about managing expectations came to be accepted by both academics and policymakers and has generated a large literature on the effects of central bank communication (Blinder et al., 2008). Earlier work by Eggertsson and Woodford (2003), among others, provides theoretical support for the argument that the central bank is relatively unconstrained by the ZLB, provided that it can credibly commit to future policy actions.

Gürkaynak, Sack, and Swanson (2005) develop a methodology to identify two dimensions of the Fed's policy surprises: changes in the current FFR target and a policy path factor orthogonal to target surprises. They show that both dimensions are useful to describe monetary policy shocks. Path surprises reflect news conveyed, via the FOMC's statement, to market participants about the expected path of the policy rate. Following Gürkaynak, Sack, and Swanson (2005), we calculate path surprises using principal component analysis. The starting point is the definition of a matrix that contains five columns and a number of rows equal to the number of relevant policy announcements. The first two columns of the matrix correspond to the changes in the price of current-month and three-month-ahead FFR futures contracts. The third to fifth columns are the changes in the prices of the second, third, and fourth eurodollar futures contracts with maturity of up to four quarters. We obtain two principal components, which are then transformed so that the first factor corresponds to current target rate surprises, while the second factor (path factor) corresponds to moves in interest rate expectations over the coming year that are not affected by changes in the current target rate.

In line with Wright (2012) and Swanson (2015), our analysis of the impact of FOMC communication, captured by path surprises, focuses on the ZLB era. This narrows the sample to 47 scheduled FOMC meetings for the period January 2009 to October 2014.[13] The average path surprise in Table 1 is equal to -0.01%, with the variable ranging from -0.62% to 0.46%.

[13]There are several unscheduled meetings during the ZLB period. These are excluded because no FOMC statements or other information related to FFR were issued.

2.1.3 LSAPs and liquidity facilities announcements

Responding to the crisis and the ZLB constraint, in addition to using more explicit forward guidance, the Fed resolved to change the size and composition of its balance sheet by the provision of non-sterilized liquidity facilities and large scale purchases of longer-term assets from the private sector, mainly mortgage backed securities (MBS) and Treasury bonds. The Fed's interventions aimed to improve financial markets conditions and to put downward pressures on long-term borrowing costs. We consider several announcements of expansionary nature, capturing the initiation or continuation of LSAPs and liquidity facilities programmes. The liquidity facilities provided by the Fed include: dollar and foreign currency liquidity swaps between the Fed and other central banks, the primary dealer credit facility, the asset-backed commercial paper money market mutual fund liquidity facility, the primary and secondary credit, seasonal credit, commercial paper funding facility, and the term auction facility (TAF).

Table 2 reports that the first such event in our sample occured on 12 December 2007, and is related to the initial announcement of the TAF and the authorization of swap lines with other central banks in order to provide liquidity in U.S. dollars to markets overseas. In total, there are 46 unique liquidity facility announcements spanning the period from December 2007 to October 2013, more than half of which are associated with TAF and central bank liquidity swaps. The Fed's liquidity facilities were heavily used in autumn of 2008 in the aftermath of the collapse of Lehman Brothers. There are also 22 LSAPs related events, with the first of these occurring on 25 November 2008 and reflecting the initial announcement of the first round of quantitative easing (QE1).[14] This was followed by the first hint about purchases of Treasuries in a speech by chairman Bernanke on 1 December 2008. It is important to note that both aforementioned announcements, along with several other LSAPs and liquidity facility announcements, do not overlap with the FOMC meetings.

Unlike FFR changes, for which we can use expectations embedded in futures contracts to isolate their surprise component, direct market-based measures of expectations regard-

[14] On that day, the Fed announced its intention to purchase $100 billion in housing-related government sponsored enterprises debt and up to $500 billion in agency mortgage backed securities.

ing LSAPs and liquidity facilities programmes are not available. Related to this point, Bernanke (2015, p.549) highlights a drawback of securities dealers' surveys conducted by the Fed to gauge securities purchases expectations: "In effect, our PhD economists surveyed their PhD economists...It didn't tell us what the rank-and-file traders were thinking." Hence, we do not attempt to measure "balance sheet shocks", in line with previous related studies (Ait-Sahalia et al., 2012; Fiordelisi, Galloppo, and Ricci, 2014; Ricci, 2015).[15] Instead, we adopt an event study approach to evaluate the behavior of stock returns in short windows surrounding the LSAPs and liquidity facility announcements.

2.2 Investor sentiment states

We employ three proxies for investor sentiment: Baker and Wurgler's (2006, 2007) Sentiment Index (BWI), the University of Michigan's Consumer Sentiment Index (CSI) and the U.S. Consumer Confidence Index (CCI).[16] The BWI is a commonly used measure of investor sentiment (Yu and Yuan, 2011; Stambaugh, Yu, and Yuan, 2012). By taking the first principal component of five financial variables that can reflect sentiment, the BWI filters out idiosyncratic noise in its constituents and captures common variation. Specifically, the BWI calculation utilises the closed-end fund discount, the number and the first-day returns of IPOs, the equity share in total new issues and the dividend premium.[17]

We also use two consumer survey-based indices, measured outside of the financial markets. The CSI is based on surveys conducted by the University of Michigan in which 500 U.S. participants are asked questions about their outlook on the economy. It has been

[15]Two notable exceptions include Rosa (2012) and Swanson (2015). The former study measures the surprise component of asset purchases by the Fed using a methodology based upon interpreting the wording of related articles in the Financial Times. Swanson (2015), on the other hand, attempts to disentangle LSAPs from forward guidance effects during the ZLB using an adaptation of the method of Gürkaynak, Sack, and Swanson (2005). He finds that stock prices respond positively to shifts in LSAPs measured as the component of FOMC announcements that is non-related to changes in forward guidance. Unlike our study, Swanson (2015) considers only events related with FOMC meetings excluding important announcements made outside FOMC meetings such as the first QE1 announcement (25 November 2008).

[16]We obtained CSI and CCI from the FRED and OECD databases, respectively. BWI data is available at Jeffrey Wurgler's website: http://people.stern.nyu.edu/jwurgler/.

[17]NYSE turnover, that featured in the set of variables used in the calculation of the sentiment index in Baker and Wurgler (2006), is dropped in the most recent update of their dataset. The updated BWI exhibits very similar behaviour over time with the earlier edition.

used by Lemmon and Portniaguina (2006) and McLean and Zhao (2014), among others, to measure investor sentiment. The CCI is another survey-based measure compiled by the Conference Board. Compared with the CSI, it uses a larger pool of respondents (5,000) and somewhat different questions. Previous studies employing CCI as a sentiment proxy include Antoniou, Doukas, and Subrahmanyam (2013). The use of such indices as sentiment indicators is supported by findings in related studies; e.g. Fisher and Statman (2003) report positive correlations between consumer confidence and measures of bullishness of individual investors about the stock market.

A rational explanation for the sentiment-dependence in the relationship between stock returns and monetary policy shocks puts emphasis on the state of the economy. In order to distinguish between behavioral and rational explanations, the effects of business cycle variation should be removed from the sentiment indicators. Baker and Wurgler (2006) orthogonalize each of the constituent variables of their sentiment index with respect to a set of macroeconomic conditions before conducting the principal component analysis.[18] We obtain the orthogonalized BWI from their data set, and also orthogonalize the CSI and CCI by regressing them on the same set of macroeconomic variables that they used. The residuals from these regressions capture sentiment (optimism or pessimism) that is not justified by economic fundamentals (Lemmon and Portniaguina, 2006). The orthogonalized sentiment indexes are standardized so that they have zero mean and unit variance.

Figure 2 plots the orthogonalized sentiment indexes. The two survey-based indices are highly correlated, while the BWI exhibits different dynamics.[19] Importantly, investor sentiment exhibits mean-reversion. Following periods of high sentiment, a correction phase ensues, during which sentiment tends to decline (Baker and Wurgler, 2006; Yu and Yuan, 2011; Chung, Hung, and Yeh, 2012). Having reached a low point, sentiment tends to build up. For example, all three indices rise during the 1990s but start to decline from around

[18]This set of macroeconomic variables include the growth in industrial production, the real growth in durable, nondurable and services consumption, the growth in employment, and a dummy variable that indicates recessions as classified by NBER business cycle dates. It is also used by other studies to remove business cycle information from sentiment proxies (Yu and Yuan, 2011; McLean and Zhao, 2014; Huang et al., 2015)

[19]The correlation coefficient between CCI and CSI is close to 1 (0.98). The correlation of BWI with the consumer-survey based proxies is close to 0.40.

year 2000, following the culmination of the "dot-com" boom. Moreover, sentiment declines during the recent global financial crisis, but somewhat recovers afterward. Nevertheless, the speed of mean reversion in sentiment is low. Visual inspection of the series in Figure 2 suggests that they are highly persistent. Quantitatively, the estimated AR(1) coefficient from a regression of monthly sentiment on a constant and its first lag over 1989-2014 ranges from 0.88 for CSI to 0.96 for BWI. The implied half-life estimates fall between 0.5 and 1.5 years.[20] It appears that it takes several months, or even years, to move from peaks to troughs in sentiment. For example, the BWI index was declining for about 1.5 years in the early 2000s before it started to recover. Narrative evidence by Baker and Wurgler (2006) and Baker and Wurgler (2007) suggests the presence of similar long-lasting sentiment cycles going back to the 1960s.

In order to examine whether the effect of monetary policy shifts on stock market price is conditional on the state of investor sentiment, we construct three alternative classifications of sentiment states. The first one is based on the level of sentiment, while the second used changes in sentiment. The third classification interacts the level- and changes-based measure to obtained a refined version of the latter one. Starting from the first classification, we use a dummy variable which is calculated using the level of the orthogonalized sentiment indexes. The dummy variable, S_t^H, is equal to 1 (0) if the FOMC meeting occurs during those years that start with high (low) sentiment level. In line with Baker and Wurgler (2006), we define a year as starting with high (low) sentiment if the sentiment indicator in December of the previous year is above (below) the full sample mean value. In our empirical analysis, this dummy reflects the effects of monetary policy news *following* periods of high sentiment. We use the terms "following periods of high sentiment" and "high start-of-the-year sentiment" interchangeably throughout the paper.

The mean-reverting nature of sentiment motivates the construction of a changes-based dummy variable, S_t^D, set to 1 (0) *during* periods of decreasing (increasing) sentiment. Given the low speed of mean reversion, we focus on a longer horizon when evaluating changes in sentiment. Hence, we define periods of decreasing sentiment as the years when

[20]Given an AR(1) model, $y_t = \alpha + \phi y_{t-1} + u_t$, the half-life is calculated as: $\ln(0.5)/\ln(\mid \phi \mid)$. The half-life reflects the time horizon that the process takes, on average, to halve its distance from the mean.

the sentiment indicator in December of a year is lower (higher) than that in December of the previous year. Note that, as Baker and Wurgler (2007) emphasize, changes in the level of their BWI should not be used to measure changes in sentiment (e.g. month-to-month, $BWI_t - BWI_{t-1}$) due to lag structures, among other considerations. Hence, we only use the CSI and CCI sentiment measures to generate dummies based on December-to-December changes.[21]

Finally, in order to explicitly capture the optimism waning phases following high sentiment, we construct our third measure of sentiment states, S_t^{HD}, which accounts for the joint effect of the sentiment's level *and* changes on the reaction of the stock market price to FFR surprises. This is a dummy variable that is equal to 1 if the FOMC meeting occurs during a year when sentiment starts at a high level but then declines, and 0 otherwise. A year is defined as starting with high sentiment which subsequently declines if the sentiment proxy in December of the previous year exceeds the full sample mean value and the sentiment proxy in December of that year is lower than in December of the previous year.

Figures 3 and 4 plot the three sentiment dummies based on the level and changes of the sentiment indexes. The changes-based dummies (S_t^D and S_t^{HD}) are more active than the level-based dummy (S_t^H), while they are both more active than the NBER recession indicator. From 2009 onwards, there is no variation in the three level-based dummy variables because they are always equal to 0, indicating low (start-of-the-year) sentiment in the aftermath of the recent financial crisis.

Table 3 reports the correlation coefficients of the sentiment-based states, along with the business cycle indicator and FFR surprises. Four stylized facts emerge. First, correlations are stronger among the two survey-based measures of sentiment and smaller between these two and the BWI measure. For example, the CSI-CCI correlation for the level-based dummy variable is 0.81, while the CSI-BWI correlation is 0.59. Second, the correlation

[21] Baker and Wurgler (2007) explain how to estimate monthly changes in investor sentiment using their methodology. In robustness checks, we calculate changes-based sentiment dummies using the average monthly sentiment changes during the year, as opposed to December-to-December changes. This enables us to incorporate the BWI in the analysis, in a way consistent with the recommendation of Baker and Wurgler (2007). The results that we obtain are in line with the baseline findings.

between level- and changes-based sentiment states is positive, which is in line with the property that sentiment is mean-reverting. Nevertheless, it is modest. This indicates that, on average, high levels of sentiment tend to be followed by a period of correction, whereby sentiment decreases. However, there are also occasions of exuberance where sentiment is high at the start of the year and rises to an even higher level by its end. Third, the simple changes-based sentiment states (S_t^D) and the NBER recession indicator are positively correlated, albeit not strongly implying that that declines in sentiment occur not only during recessions but also during expansions (see also Figures 2 and 4). Note that the correlation becomes insignificant when the refined changes-based states (S_t^{HD}) are considered, highlighting their distinct nature. Finally, the correlation between FFR surprises and sentiment states is low.

3 Econometric models and results

This section contains event study estimates of the stock market response to monetary policy actions. Section 3.1 analyzes the impact of conventional monetary policy shocks over the sample period June 1989 - December 2008, i.e. before the ZLB. Section 3.2 discusses potential explanations. Section 3.3 examines the effect of non-conventional monetary policy. We consider path surprises at the ZLB (January 2009 - October 2014) in Section 3.3.1 and announcements regarding LSAPs and liquidity facilities in Section 3.3.2.

3.1 The impact of conventional monetary policy before the ZLB

We begin our empirical investigation by examining the response of stock market returns to target FFR surprises on FOMC announcement days conditional on the start-of-the-year level of sentiment. To this end, we introduce an interaction term of the FFR surprise with the previously defined level-based sentiment dummy, S_t^H, in the following regression model with heteroskedasticity-consistent standard errors:

$$R_t = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^u + \beta_2 S_t^H \Delta i_t^u + \varepsilon_t \tag{2}$$

where R_t denotes the daily CRSP value-weighted return in excess of the 1-month Treasury bill rate in the event space between the end of the FOMC announcement day t and the end of the previous trading day $t-1$. We also use CRSP equally-weighted returns.

Panel A of Table 4 reports estimates of Equation 2. Starting with value-weighted returns, the stock market reaction to unexpected FFR changes when sentiment is high at the beginning of the year ($S_t^H = 1$), as captured by β_2, is significant, both economically and statistically. The negative sign of β_2 indicates that the stock market responds positively (negatively) to monetary easing (tightening) shocks. The results reveal an about 2% one-day excess stock market return in response to an unexpected cut of 25 basis points in the FFR, following periods of high sentiment. On the other hand, when sentiment is low at the start of the year the market response to FFR surprises, as captured by β_1, is statistically insignificant. Hence, the impact of monetary policy news is stronger following periods of high sentiment. We obtain similar results when we employ alternative econometric specifications that use "raw" sentiment data, as opposed to sentiment states dummies, and account for the effect of past sentiment on returns (see Table A6 in the Online Appendix).

Using equally-weighted market returns, the magnitude of the effect of FFR shocks following periods of high sentiment, declines by about a third as compared with the case of value-weighed returns. Nevertheless, the effect remains sizeable and statistically significant. Thus, the market response to target rate surprises is not exclusively driven by the reaction of large stocks. Finally, using the full sample (June 1989 - October 2014) and a pre-crisis sample (June 1989 - August 2007), we obtain similar results for value- and equally-weighted returns (available upon request).[22]

As reported earlier in Table 3 that the level- and changes-based sentiment states show a positive correlation, consistent with the mean-reversion property of sentiment. This prompts us to examine whether changes in investor sentiment affect the stock price

[22]We date the start of the financial crisis to September 2007. By the end of the summer in 2007 major doubts about the stability of the financial system had emerged and the first major central bank interventions in response to increasing interbank market pressures took place. In September 2007, the Fed proceeded to the first major FFR cut (0.5%) since 2003, hence initiating a long cycle of monetary expansion. The 2007-2009 dating scheme is consistent with previous analyses of the recent financial crisis (Kontonikas, MacDonald, and Saggu, 2013).

response to FFR shocks. Therefore, we replace the sentiment level-based dummy variable in Equation 2 with the simple changes-based dummy, S_t^D, and then estimate Equation 3:

$$R_t = \beta_0 + \beta_1(1 - S_t^D)\Delta i_t^u + \beta_2 S_t^D \Delta i_t^u + \varepsilon_t \tag{3}$$

The results, as presented in Panel B of Table 4, reveal that the stock market responds significantly to FFR shocks during periods of decreasing investor sentiment ($S_t^D = 1$), as captured by β_2. In contrast, the impact of monetary policy news on the stock market is insignificant when sentiment is increasing. Furthermore, we re-estimate Equation 3 using the refined changed-based sentiment state indicator, S_t^{HD}, that accounts for the joint effect of the sentiment's level *and* changes on the reaction of the stock market price to FFR surprises. Panel C of Table 4, reports the results, and provides further evidence on the important role of sentiment states in the transmission of monetary policy shocks to the stock market. In particular, we find that the effect of policy shifts is statistically significant only during years when sentiment starts at high level but then subsequently declines. Estimates of the coefficient of interest (β_2) are close in magnitude to those reported in Panel A, where the sentiment dummy is solely based on the level on sentiment.

Finally, we also consider a 4-way decomposition in which we use dummies to classify periods of high & increasing, high & decreasing, low & increasing, and low & decreasing sentiment. The findings (available upon request) are consistent with those reported in Table 4, and show that the response of the stock market price to FFR shocks is statistically significant only during periods of high & decreasing sentiment, that is, when sentiment is hight at the start of the year but then falls. On the other hand, during periods of exuberance (depression) when sentiment is already high (low) and keeps increasing (decreasing) the effect of monetary policy news on the stock market is statistically insignificant. The same holds for periods of optimism building-up when sentiment is low at the start of the year but then rises.

These findings seem to suggest that the impact of monetary policy actions is mostly potent when sentiment-driven overvaluation is followed by a stock price correction. To examine this conjecture, we plot S_t^{HD} along with a bear market indicator in Figure 5.

While there is no commonly accepted definition for bull vs. bear market states, the bear indicator that we use is consistent with the standard notion of significant and sustained stock price declines. It is a dummy variable that is equal to 1 when the S&P 500 index is lower than its full sample 2-year moving average, and 0 otherwise (Kontonikas, MacDonald, and Saggu, 2013). Figure 5 shows that sentiment waning phases ($S_t^{HD} = 1$) sometimes overlap with bear market episodes, for example the one associated with the recent global financial crisis. However, sentiment waning also occurs during bull markets. The correlation between sentiment waning phases and bear markets is small (0.2). Therefore, our analysis is distinct from previous studies that condition the stock market response to policy surprises on bear vs. bull states, and find a stronger response during bears (Chen, 2007; Kurov, 2010). Unreported findings (available upon request) show that the stock market response to FFR surprises during sentiment waning phases is strongly significant during both bear and bull markets, and insignificant otherwise.

Our analysis has so far focused on the contemporaneous effect of FFR shocks on the stock market. We further examine whether the significant contemporaneous impact persists over time. To this end, we compute 2- and 3-day cumulative stock market returns and estimate their corresponding response coefficients to FFR shocks. In particular, we estimate the following regression model:

$$R_{t,t+\tau} = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^u + \beta_2 S_t^H \Delta i_t^u + \varepsilon_t \tag{4}$$

where $R_{t,t+\tau}$ denotes the cumulative 2-day ($\tau = 1$) excess CRSP market return calculated at the end of the next trading day following the FOMC announcement, and cumulative 3-day return ($\tau = 2$).

The left hand panel of Panels A and B of Table 5 report the results for 2- and 3-day cumulative returns, respectively, which we summarize as follows. First, the FFR shocks affect the stock market only following periods of high sentiment. Second, the response of 2-day cumulative returns to monetary policy news is strongly significant, with a magnitude somewhat higher than that of the contemporaneous response in Table 4. Third, when we calculate returns over a 3-day window the magnitude and statistical

significance of the returns response is diminished. Hence, the impact of policy surprises is predominantly contemporaneous and displays some persistence only in the very short-run (see also Florackis, Kontonikas, and Kostakis (2014)). Using the refined changes-based sentiment indicator, we obtain similar results as reported at the right hand panel of Table 5.

Equation 2 assumes a symmetric stock market reaction to monetary policy surprises with no distinction between expansionary shocks and contractionary shocks. It is plausible that the stock market response may depend on the type of news, as classified by the sign of the monetary policy shock. Previous evidence by Bernanke and Kuttner (2005) provides only weak support for this type of asymmetry. Neuhierl and Weber (2017) and Ozdagli and Weber (2017), on the other hand, provide evidence in line with a more important role for expansionary surprises. However, these studies do not account for sentiment states in their analyses. To gain more insight on potential policy asymmetries, we augment Equation 2 and estimate the following regression model that allows for both sentiment dependence and sign asymmetry:

$$R_t = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^{un} + \beta_2(1 - S_t^H)\Delta i_t^{up} + \beta_3 S_t^H \Delta i_t^{un} + \beta_4 S_t^H \Delta i_t^{up} + \varepsilon_t \qquad (5)$$

where Δi_t^{un} and Δi_t^{up} denote negative and positive unexpected FFR target rate changes, respectively. The negative FFR surprise is defined as: $\Delta i_t^{un} = \Delta i_t^u D_t^n$, where D_t^n is a dummy variable equal to 1 if $\Delta i_t^u < 0$, and 0 otherwise. Likewise, the positive FFR surprise is: $\Delta i_t^{up} = \Delta i_t^u D_t^p$, where D_t^p is a dummy variable equal to 1 if $\Delta i_t^u > 0$, and 0 otherwise.

Table 6 reports estimates of Equation 5. Crucially, we find that only in response to expansionary surprises does the stock market price show strong reaction to FFR shocks during sentiment waning periods. This effect is captured by β_3, which is negative and significant at the 1% level across all alternative specifications. On the other hand, the effect of tightening surprises is always statistically insignificant, irrespectively of the state of investor sentiment. Hence, the stock market response to monetary policy news is highly asymmetric, driven by expansionary surprises, and at the same time, is conditional

on investor sentiment. Moreover, Table A4 in the Online Appendix demonstrates that the policy asymmetry carries through to the response of market-wide risk aversion to FFR surprises in that only expansionary shocks matter. These results are not driven by the concentration of policy surprises in a particular sentiment state. Particularly, expansionary, as well as tightening, shocks occur across both sentiment states (see Table A5 in the Online Appendix).

3.2 Addressing potential explanations

In the previous section we document the strong effect of monetary policy on the stock market during sentiment waning phases. In this section we address potential explanations for the findings. We first propose an explanation and then consider alternative explanations as well as potential confounding factors. With the exception of the intraday analysis in Section 3.2.4 where we use all three alternative sentiment state indicators, here we focus on the S_t^H and S_t^{HD} measures. For brevity, we write the regression models only using the on the S_t^H indicator.

3.2.1 Alleviating investor fear

Our proposed explanation is that monetary policy actions alleviate investors' fear. In theoretical models of the risk-taking channel of monetary policy, a reduction in the policy rate causes higher risk-taking by financial institutions, resulting in lower risk premia and amplifying the magnitude of the interest rate cut (Adrian and Shin, 2010; Drechsler et al., 2018). Previous empirical studies typically provide evidence in support of greater propensity for riskier investments by banks, mutual funds, pension funds and other financial institutions when monetary policy is expansive (Jiménez et al., 2014; Dell'Ariccia et al., 2017; Di Maggio and Kacperczyk, 2017; Chodorow-Reich, 2014).[23] Besides, empirical evidence demonstrates that accommodative monetary policy reduces the credit spreads of firms (Gertler and Karadi, 2015), the equity premium (Bernanke and Kuttner, 2005; Bianchi et al., 2016) and market-based measures of risk aversion (Bekaert, Hoerova, and

[23]Lian et al. (2018) present evidence which suggests that this behaviour is not confined to financial institutions, but also applies to individuals and can be driven by preferences and psychology.

Duca, 2013).

In order to capture aggregate market risk aversion, Bekaert, Hoerova, and Duca (2013) use a decomposition of the option-implied expected volatility on the S&P500 index (VIX). The VIX index, commonly interpreted as a "fear gauge" by financial market participants, reflects both stock market uncertainty (the "physical" expected volatility) and a variance risk premium (VRP). The VRP, obtained as the difference between the squared VIX index and expected realized market volatility, measures risk aversion at the market level and has been shown to predict stock returns (Bollerslev et al., 2009; Drechsler and Yaron, 2010; Bekaert and Hoerova, 2014). In line with Bekaert, Hoerova, and Duca (2013), we obtain an estimate of the expected future realized volatility using daily data.[24]

To examine the effect of monetary policy on risk aversion, we re-estimate Equation 2 by replacing the stock market return with the change in the VRP as the dependent variable. Table 7 reports the results. We find strong evidence for fear alleviation conditional upon the state of investor sentiment. Specifically, the positive sign and statistical significance of β_2 indicate that the market-wide risk aversion declines in response to monetary easing shocks only during sentiment waning phases. Taken together, the results in Tables 4 and 7 suggest that sentiment-dependent stock market response to monetary policy shocks may be attributed to shifts in the willingness of investors to bear risk. In addition, the sentiment-driven response of VRP changes to monetary policy that we document builds upon and extends Bekaert, Hoerova, and Duca (2013) who do not consider the role of sentiment.

To examine this possibility within our framework, we interact states defined by sentiment with those defined by the state of the monetary policy cycle. Specifically, we estimate Equation 6, which conducts a 4-way decomposition of the monetary policy impact:

$$\begin{aligned} R_t = \beta_0 &+ \beta_1(1 - S_t^H)(1 - Eas_t)\Delta i_t^u + \beta_2(1 - S_t^H)Eas_t\Delta i_t^u \\ &+ \beta_3 S_t^H(1 - Eas_t)\Delta i_t^u + \beta_4 S_t^H Eas_t\Delta i_t^u + \varepsilon_t \end{aligned} \tag{6}$$

where Eas_t is a dummy variable that equals 1 if the FOMC meeting occurred during

[24]The squared VIX and the past realized variance are used as predictors. We thank Nikos Vlastakis for providing us with the data.

a monetary easing cycle and 0 otherwise. An easing cycle is defined as starting with a FFR target rate cut and ending with a FFR target rate rise, consistent with Lucca and Moench (2015). Figure 6 plots the dummy variable that reflects monetary cycles. We identify five easing cycles over the full sample period: the first three occurred in the 1990s, and the other two in the 2000s. While recessionary periods always overlap with expansionary monetary policy cycles, the latter have typically longer duration and proceed and/or continue after recessions. For example, the early 2000s expansionary cycle commenced in January 2001 and ended in May 2004, thereby encompassing a shorter-lived recessionary episode that lasted from March to November of 2001. The correlation between the monetary cycle and the business cycle indicators is positive but low (0.25). Table 8 shows that the effect of sentiment waning phases on the transmission of monetary policy news to the stock market materializes during easing cycles, as captured by β_4.

3.2.2 Business cycle and monetary policy cycle effects

Previous studies show that the impact of monetary policy on the stock market is stronger during economic recessions (Basistha and Kurov, 2008; Perez-Quiros and Timmermann, 2000). To examine this conjecture, we interact our sentiment states with business cycle indicators. To do so, we replace Eas_t with Rec_T in Equation 6. where Rec_t is a variable that captures the state of the economy, which we measure by the NBER business cycle chronology ($NBER_t$) and the real time probability of recession ($Recprob_t$). $NBER_t$ is a dummy variable that is equal to 1 if the FOMC meeting occurred during a month that U.S. economy is in recession, as classified by the NBER business cycle dates. $Recprob_t$ is equal to the real time recession probability for the month when the FOMC meeting takes place, obtained from the dynamic-factor Markov-Switching model of Chauvet and Piger (2008), sourced from the FRED database. There is a close correspondence between the two business cycle indicators, with the correlation coefficient being equal to 0.9.

The estimation results in Panel A of Table 9 reveal that only outside recessions do stock market returns respond significantly to FFR shocks during sentiment waning phases, as captured by β_3. The corresponding effect during recessions, as captured by β_4, is statis-

tically insignificant, albeit with a fairly large magnitude. Using the recession probability indicator in Panel B, we obtain similar results. Hence, the main challenge for explanations based upon bad economic states is the disconnect between recessions and the stock market response to policy shocks, once sentiment has been accounted for. Our findings highlight the importance of sentiment states that previous studies do not consider when analyzing the the effect of monetary policy on the stock market over the business cycle.

3.2.3 Accounting for joint-response bias and other endogeneity concerns

Apart from the possibility of reverse feedback, as implied by the "Fed put" narrative, event-study endogeneity may also arise due to the simultaneous reaction of stocks and the market-based policy surprise proxy to new information. For instance, news indicating a weaker economic outlook would tend to reduce stock valuations and make an FFR cut more likely, implying a downward bias in the size of the estimated policy impact (Bernanke and Kuttner, 2005). Thornton (2014) proposes a procedure to address the joint-response bias which has some important advantages relative to alternative methods. It is simple to implement, provides an indication of the magnitude of the joint-response bias, and does not rely on either the use of intraday data or the identification through heteroscedasticity of Rigobon and Sack (2004). The latter method makes strong assumptions regarding the variance of shocks on FOMC meetings vs. other days.

Thornton's (2014) method involves using the market-based monetary policy surprises on all days as a latent variable. This variable accounts for the link between stock returns and market-based policy surprises on days when there are no news from the Fed. In order to account for the joint-response bias that arises due to the reaction of stock returns and the market-based proxy to "ambient news", rather than monetary policy actions, the following regression model can be estimated using daily data:

$$R_t = \beta_0 + \beta_1 FOMC_t + \beta_2 \Delta i_t^u + \beta_3 FOMC_t \Delta i_t^u + \varepsilon_t \tag{7}$$

where $FOMC_t$ is a dummy variable that is equal to 1 on FOMC announcement days and 0 otherwise.

In Equation 7, the β_2 coefficient reflects the joint-response bias, whereas β_3 denotes the marginal change in stock returns associated with unexpected policy events. Thornton (2014) uses a similar model to evaluate the results from an event study considering changes in Treasury yields around FOMC announcements. He shows that the joint-response bias in the Treasuries' event study is large, since in contrast to β_2 which is always significant, β_3 is insignificant in many cases. However, estimates of Equation 7 using stock market returns as the dependent variable, provide little evidence to support the joint response bias. Specifically, β_2 is significant only at the 10% level, while β_3 is significant at the 1% level and its magnitude is close to non-corrected event study estimates (results are available upon request). We modify Thornton's framework to account for sentiment states by considering Equation 8:

$$\begin{aligned} R_t = \beta_0 + \beta_1(1 - S_t^H)FOMC_t + \beta_2(1 - S_t^H)\Delta i_t^u + \beta_3(1 - S_t^H)FOMC_t\Delta i_t^u \\ + \beta_4 S_t^H FOMC_t + \beta_5 S_t^H \Delta i_t^u + \beta_6 S_t^H FOMC_t \Delta i_t^u + \varepsilon_t \end{aligned} \tag{8}$$

where S_t^H is a dummy variable that is equal to 1 (0) during a year that starts with high (low) sentiment level.

The results from estimating Equation 8 are presented in Table 10. Following periods of high sentiment, estimates of the joint response bias and the marginal effect of unexpected policy actions, as respectively captured by β_5 and β_6, are both highly significant. Their sum is somewhat smaller relative to the baseline findings in Panel A of Table 4, which are not adjusted for the joint-response bias. However, the differences are not statistically significant. Overall, adjusting for joint-response bias makes little difference. For example, following high sentiment periods defined using the CSI, the bias-corrected effect of policy surprises in Table 10 is -7.68, close to the -7.17 non-corrected impact in Panel A of Table 4. On the other hand, following periods of low sentiment, all related estimates are statistically insignificant at the 5% level. Overall, these results imply that the joint-response bias is relatively small and the event study estimates are reliable.

According to the "Fed put" story, policy is eased in times of trouble, such as the

Long-Term Capital Management (LTCM) crisis (Ozdagli, 2017; Neuhierl and Weber, 2017), but not tightened accordingly when financial conditions are good. Cieslak and Vissing-Jorgensen (2017) show that low cumulative stock returns prior to the FOMC meeting predict accommodating monetary policy. It is worth to note that this argument focuses on stock market developments that predate FOMC meetings. Therefore, it is less relevant to our analysis which centers on FOMC-day developments captured by our dependent variable (FOMC day returns). Even if the Fed reacted to stock returns on FOMC meeting days, this would tend to reduce the size of the estimated response to FFR surprises. Hence, the event study approach may yield conservative estimates of the stock market's reaction to policy shifts (Bernanke and Kuttner, 2005).

3.2.4 Pre-announcement effect, information leakage, and the role of unscheduled meetings

Lucca and Moench (2015) document large average excess returns in the U.S. stock market in anticipation of monetary policy decisions made at scheduled FOMC meetings. The monetary policy announcements typically occur at 2:15 PM (EST). Thus, the daily returns on FOMC meeting days incorporate a pre-announcement window, implying that our results may be confounded by the pre-FOMC announcement drift. To rule out such effects, we turn to intraday data and calculate the stock market return, proxied by the S&P500 index, over a short period surrounding the FOMC announcement. Specifically, we start by considering a 30-minutes window, starting 10 minutes before the FOMC announcement and ending 20 minutes after (-10, 20). We also use a wider window that spans 120 minutes (-10, 110). Bernile, Hu, and Tang (2016) and Kurov et al. (2017) also focus on pre-announcement effects and provide evidence consistent with information leakage during the FOMC news embargo period. To ensure that our results are not driven by news leakages during the embargo period, we employ a tighter lower bound in our windows corresponding to 1-minute before the announcement: (-1, 20) and (-1, 110).

To isolate the impact of news about monetary policy more sharply and mitigate endogeneity concerns, FFR surprises are also calculated using intraday data. We use the same

windows as in the case of stock returns. The intraday-frequency approach in identifying monetary policy shocks is in line with Gürkaynak, Sack, and Swanson (2005), and Gertler and Karadi (2015), among others. The sources of intraday data are TickData and CME Group for the S&P500 index and FFR futures prices, respectively. Note that the FFR futures data are only available from January 1995. Thus, the estimations have a later start date relative to the baseline daily analysis.

Panel A in Table 11 reports estimates of Equation 2 using intraday data. They show that the effect of sentiment on the transmission of FFR shocks to the stock market is robust to the use of a sharper window for the identification of policy surprises and the relevant stock market reaction. Estimates of β_2 are highly significant, while β_1 is always insignificant, using all three alternative sentiment state proxies (S_t^H, S_t^D, and S_t^{HD}).[25] Thus, the stock market only responds to FFR shocks during sentiment waning phases. When a narrow window is used, the results reveal a somewhat weaker reaction relative to the corresponding daily estimates. For example, using CCI the β_2 estimate in Panel C of Table 11 is -5.38 when the embargo window period is included, as compared with -8.20 in Table 4. However, the intraday estimates tend to approach the corresponding daily estimates as the upper bound of the window is expanded to about 2-hours following the announcement. Finally, the exclusion of the embargo period leads to slightly smaller, but still strongly significant, estimates of the FFR shocks' effect during sentiment waning episodes. All in all, intraday evidence suggests that our results are not driven by the pre-announcement effect and/or information leakage.

Furthermore, unscheduled meetings are the ultimate manifestations of the "Fed put" story. With the exception of two cases, unscheduled FOMC meetings are associated with expansionary policy surprises (see Table A2 in the Online Appendix). Bernanke (2015) also highlights that a rate move between regularly scheduled FOMC meetings is usually taken responding to an emergency. To examine whether our results regarding the importance of expansionary surprises are driven by the incorporation of unscheduled,

[25]Note that over the sample period January 1995 - December 2008, S_t^H equals 1 for the case of CSI. Hence, the level dummy cannot be used in our estimations since it does not exhibit variation. Furthermore, S_t^D and S_t^{HD} identify the same regimes.

and possibly endogenous, FOMC meetings in the sample, we remove all unscheduled meetings from the sample and then re-estimate Equation 2. The results reported in Table 11 show that, overall, the effect of expansionary surprises is robust to the exclusion of unscheduled meetings. The magnitude of β_3 mildly declines but the effect remains statistically significant in all cases. Hence, alleviating the possibility of reverse-feedback type of endogeneity does not alter our key conclusions. The low correlation between FFR surprises and sentiment state indicators (see Table 3) further safeguards our results from the concern of the "Fed put".

3.3 The impact of non-conventional monetary policy

Having analysed the stock market effect of conventional monetary policy surprises before the ZLB, in this section we turn to the impact of non-conventional monetary policy.

3.3.1 Path surprises at the ZLB

We examine the impact of path surprises on stock returns during the ZLB era between January 2009 and October 2014. The level-based sentiment dummy variable cannot be used to identify sentiment states since, as shown in Figure 3, it is equal to zero throughout the ZLB period. The same applies for the refined changes-based dummy variable, and therefore we do not use it. On the other hand, the simple changes-based sentiment dummy exhibits some variation at the ZLB, as displayed in Figure 4 (left hand panel). Since 2005 the CSI and CCI changes-based dummies overlap; therefore we only use the CSI changes-based dummy to identify the impact of the state of sentiment on the response of stock market returns to path surprises in the ZLB era:

$$R_t = \beta_0 + \beta_1(1 - S_t^D)path_t + \beta_2 S_t^D path_t + \varepsilon_t \tag{9}$$

Consistent with our findings from analyzing FFR shocks, Panel A of Table 12 shows that the stock market response to path surprises is statistically significant during periods of decreasing sentiment, with the negative sign of β_2 indicating a positive (negative)

response to expansionary (tightening) path surprises. In contrast, the impact of path surprises is not significant during periods of increasing sentiment. Our results are in agreement with Wright (2012) and Swanson (2015), who find that expansionary monetary policy shocks boosted the stock market during the ZLB period. Importantly, however, we show that this effect materializes only when sentiment is declining.

In Section 4.1.2 we document sign asymmetry in the effect of FFR shocks. Here, we estimate a model which allows for sentiment dependence and sign asymmetry related to the impact of path surprises:

$$R_t = \beta_0 + \beta_1(1 - S_t^D)path_t^n + \beta_2(1 - S_t^D)path_t^p + \beta_3 S_t^D path_t^n + \beta_4 S_t^D path_t^p + \varepsilon_t \quad (10)$$

where $path_t^n$ and $path_t^p$ denote negative and positive path surprises, respectively. Negative path surprises are calculated as $path_t^n = path_t D_t^n$, where D_t^n is a dummy variable that is equal to 1 if $path_t < 0$, and 0 otherwise. Positive path surprises are calculated as $path_t^p = path_t D_t^p$, where D_t^p is a dummy variable that is equal to 1 if $path_t > 0$, and 0 otherwise.

Panel B of Table 12 reports estimates of Equation 10 and shows that the reaction of stock market returns to path surprises during periods of decreasing sentiment is not only driven by expansionary shocks. In fact, the effect of tightening path surprises, as depicted by β_4, is almost twice in magnitude compared with that of expansionary surprises as captured by β_3. On the other hand, irrespectively of their sign, the effect of path surprises is always statistically insignificant during increasing sentiment periods. These findings highlight an important difference between the response of stock market returns to FFR shocks before the ZLB and the reaction to path surprises at the ZLB.

3.3.2 LSAPs and liquidity facilities announcements

We analyze the effects of the Fed's interventions, through LSAPs and the provision of liquidity facilities, between December 2007 and October 2013. We adopt an event study approach in which we calculate and evaluate abnormal returns (ARs) in short windows

surrounding non-conventional policy announcements of expansionary nature; that is, announcements related to the initiation or continuation of LSAPs and liquidity facilities programmes. We focus on the following event windows: 5 days (-1, +3), i.e. one day before and three days following an announcement; 3 days (-1, +1); and one day (0, 0). By keeping the event window narrow, we are able to identify the announcement effect because this avoids contaminating the impact of one particular announcement with that of previous and subsequent announcements (Ait-Sahalia et al., 2012).

We further classify these events according to the state of investor sentiment at the time when they occur, and then conduct event study analysis across each of the sentiment states. Since there is little variation in the level-based sentiment dummy over the period of the non-conventional policy announcements, we only use the CSI changes-based dummy to define sentiment states.[26] For example, there are 13 events related to the announcements of central bank liquidity swaps, 9 of which occurred during periods of decreasing sentiment, and the remaining 4 occured during periods of increasing sentiment.[27]

We obtain ARs using the constant mean model (MacKinlay, 1997) and a 20-day estimation period that ends prior to the event window. We calculate the Cumulative Average Abnormal Returns (CAARs) and test whether a market reaction is significantly different from zero using the Boehmer, Masumeci, and Poulsen (1991) test statistic that addresses the event-induced increase in return volatility (Ricci, 2015). To do so, we first obtain the cumulative standardized abnormal returns (CSARs):

$$CSAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} \frac{AR_{i,t}}{S(AR_i)} \tag{11}$$

where (t_1, t_2) is the event window and $S(AR_i)$ denotes the standard deviation of abnormal returns. The standardized t test statistic is then calculated as follows:

$$t = \frac{\frac{1}{N}\sum_{i=1}^{N} CSAR_i(t_1, t_2)}{\sqrt{\frac{1}{N(N-1)}[CSAR_i(t_1, t_2) - \frac{1}{N}\sum_{i=1}^{N} CSAR_i(t_1, t_2)]^2}} \tag{12}$$

[26] As we pointed out earlier, the values taken by the CSI and CCI changes-based dummies are the same since 2005.

[27] The announcements related to TAF and liquidity facilities other than central bank liquidity swaps occurred only during periods of decreasing sentiment.

where N is the number of observations in the sample.

Table 13 reports that the stock market benefits from the Fed's establishment of the US dollar and foreign-currency liquidity lines. This effect is conditional, however, on the state of investor sentiment, manifesting itself only during periods of decreasing sentiment. The CAARs are positive and significant in two out of three event windows that we analyze. There is a tendency for the CAARs to increase as the window expands.[28] For example, the (0, 0) CAAR associated with the announcement of central bank liquidity swaps during periods of decreasing sentiment is 1.51%, increasing to 3.11% when the window expands to (-1, +1) days. The market response to other announcements (LSAPs, TAF and other liquidity facilities) is statistically insignificant. Our evidence is consistent with the existing literature on the positive impact of expansionary non-conventional monetary policy on the stock market (Rosa, 2012; Wright, 2012; Fiordelisi, Galloppo, and Ricci, 2014), and highlights the important role played by central bank liquidity swaps. Crucially, we show that it is important to account for the sentiment environment at the time when these announcements take place.

4 Robustness checks

We conduct a host of robustness checks and our findings remain unchanged. The results are presented and discussed in the Online Appendix. In line with our main analysis, when we consider the impact of FFR shocks, we focus on the pre-ZLB period and use the level-based together with the refined changes-based sentiment states. In evaluating the effect of path surprises, we use the ZLB sample period and the simple changes-based sentiment states. The first check uses alternative econometric specifications for the baseline model (Table A7). The next two checks involve estimating the impact of FFR shocks with the removal of FOMC meetings that coincide with employment data releases (Tables A8), and using an alternative sample starting point (Table A9). In the fourth check, we use the index of Huang et al. (2015) to identify sentiment states (Table A10). The fifth check

[28] As Ait-Sahalia et al. (2012) argue, a wider post-announcement window allows for the news to be absorbed over a more extended period, which is sensible given the unprecedented nature of most of these initiatives.

considers an estimation method that is robust to the presence of outliers (Tables A11). The sixth check concerns the approach that we use to identify sentiment states (Table A12). The seventh uses additional macro-related variables for the orthogonalization of the sentiment indexes (Tables A13). Finally, we use a longer estimation window to investigate the impact of LSAPs and liquidity facilities announcements (Table A14).

5 Conclusions

In this study we show that the state of investor sentiment strongly affects the transmission of monetary policy news to the stock market. We employ measures of monetary policy that capture conventional and non-conventional approaches of the Fed's actions, along with several proxies for investor sentiment. The impact of monetary policy news is potent during the sentiment waning phases that follows optimistic episodes, in particular, when sentiment is high at the start of the year and then declines. In contrast, during periods when optimism grows, the impact of monetary policy news is statistically insignificant. The effects we document are not related to business cycle variation since they do not capture recessionary episodes, and are not related to bear markets. An important finding of this study is that only expansionary news matters.

Our findings are consistent with a possible explanation relates to investors' greater sensitivity to news during sentiment downturns and become more sensitive to monetary policy shocks during sentiment-waning phases. Especially more so, when faced with expansionary monetary policy shocks that may alleviate, at least temporarily, the anxiety and fear of investors. In contrast, when optimism grows, the overvaluation of stocks attenuates the impact of monetary policy news and hence, the marginal price impact of monetary policy news is limited.

This study brings together two strands of the existing literature by seeking to incorporate lessons from behavioural finance to research about the impact of monetary policy on financial markets. The findings suggest several avenues for future work. For example, one could adopt a returns decomposition approach to shed light into whether the stock market response during a sentiment waning phase is related to adjustments in ex-

pected cash flows and/or expected returns. Moreover, policymakers should be aware of the asymmetries that we document when calibrating the impact of monetary surprises.

References

Adrian, T. and H. S. Shin (2010). Financial Intermediaries and Monetary Economics. In B. M. Friedman and M. Woodford (Eds.), *Handbook of Monetary Economics*, Volume 3, Chapter 12, pp. 601 – 650. Elsevier.

Ait-Sahalia, Y., J. Andritzky, A. Jobst, S. Nowak, and N. Tamirisa (2012). Market response to policy initiatives during the global financial crisis. *Journal of International Economics 87*(1), 162–177.

Antoniou, C., J. A. Doukas, and A. Subrahmanyam (2013). Cognitive dissonance, sentiment, and momentum. *Journal of Financial and Quantitative Analysis 48*(01), 245–275.

Antoniou, C., J. A. Doukas, and A. Subrahmanyam (2015). Investor sentiment, beta, and the cost of equity capital. *Management Science 62*(2), 347–367.

Baker, M. and J. Wurgler (2006). Investor sentiment and the cross-section of stock returns. *Journal of Finance 61*(4), 1645–1680.

Baker, M. and J. Wurgler (2007). Investor sentiment in the stock market. *Journal of Economic Perspectives 21*(2), 129–152.

Balvers, R. J. and D. Huang (2009). Money and the C-CAPM. *Journal of Financial and Quantitative Analysis 44*(02), 337–368.

Basistha, A. and A. Kurov (2008). Macroeconomic cycles and the stock market's reaction to monetary policy. *Journal of Banking and Finance 32*(12), 2606–2616.

Bekaert, G. and M. Hoerova (2014). The vix, the variance premium and stock market volatility. *Journal of Econometrics 183*(2), 181–192.

Bekaert, G., M. Hoerova, and M. L. Duca (2013). Risk, uncertainty and monetary policy. *Journal of Monetary Economics 60*(7), 771–788.

Bernanke, B. S. (2013, November 19). Communication and monetary policy. *Speech at the National Economists Club Annual Dinner, Herbert Stein Memorial Lecture, Washington, DC*.

Bernanke, B. S. (2015). *The Courage to Act: A Memoir of a Crisis and its Aftermath* (1st ed.). W. W. Norton & Company.

Bernanke, B. S. and K. N. Kuttner (2005). What explains the stock market's reaction to Federal Reserve policy? *Journal of Finance 60*(3), 1221–1257.

Bernanke, B. S. and I. Mihov (1998). Measuring monetary policy. *Quarterly Journal of Economics 113*(3), 869–902.

Bernile, G., J. Hu, and Y. Tang (2016). Can information be locked up? Informed trading ahead of macro-news announcements. *Journal of Financial Economics 121*(3), 496–520.

Bianchi, F., M. Lettau, and S. C. Ludvigson (2016). Monetary policy and asset valuation. Technical report, National Bureau of Economic Research.

Blinder, A. S., M. Ehrmann, M. Fratzscher, J. De Haan, and D.-J. Jansen (2008). Central bank communication and monetary policy: A survey of theory and evidence. *Journal of Economic Literature 46*(4), 910–45.

Boehmer, E., J. Masumeci, and A. B. Poulsen (1991). Event-study methodology under conditions of event-induced variance. *Journal of Financial Economics 30*(2), 253–272.

Bollerslev, T., G. Tauchen, and H. Zhou (2009). Expected stock returns and variance risk premia. *Review of Financial Studies 22*(11), 4463–4492.

Cen, L., H. Lu, and L. Yang (2013). Investor sentiment, disagreement, and the breadth–return relationship. *Management Science 59*(5), 1076–1091.

Cenesizoglu, T. (2014). The reaction of stock returns to news about fundamentals. *Management Science 61*(5), 1072–1093.

Chauvet, M. and J. Piger (2008). A comparison of the real-time performance of business cycle dating methods. *Journal of Business and Economic Statistics 26*(1), 42–49.

Chen, S.-S. (2007). Does monetary policy have asymmetric effects on stock returns? *Journal of Money, Credit and Banking 39*(2-3), 667–688.

Chodorow-Reich, G. (2014). Effects of unconventional monetary policy on financial institutions. *Brookings Papers on Economic Activity*, 193.

Chordia, T. and L. Shivakumar (2002). Momentum, business cycle, and time-varying expected returns. *Journal of Finance 57*(2), 985–1019.

Chung, S.-L., C.-H. Hung, and C.-Y. Yeh (2012). When does investor sentiment predict stock returns? *Journal of Empirical Finance 19*(2), 217–240.

Cieslak, A., A. Morse, and A. Vissing-Jorgensen (2018). Stock returns over the FOMC cycle. Unpublished paper.

Cieslak, A. and A. Vissing-Jorgensen (2017). The economics of the fed put. Unpublished paper.

Da, Z., J. Engelberg, and P. Gao (2011). In search of attention. *Journal of Finance 66*(5), 1461–1499.

De Long, J. B., A. Shleifer, L. H. Summers, and R. J. Waldmann (1990). Noise trader risk in financial markets. *Journal of Political Economy 98*(4), 703–738.

Dell'Ariccia, G., L. Laeven, and G. A. Suarez (2017). Bank leverage and monetary policy's risk-taking channel: evidence from the united states. *Journal of Finance 72*(2), 613–654.

DeVault, L., R. W. Sias, and L. T. Starks (2018). Sentiment metrics and investor demand. *Journal of Finance, Forthcoming*.

Di Maggio, M. and M. Kacperczyk (2017). The unintended consequences of the zero lower bound policy. *Journal of Financial Economics 123*(1), 59–80.

Doh, T. and M. Connolly (2013). Has the effect of monetary policy announcements on asset prices changed? *Economic Review–Federal Reserve Bank of Kansas City Third Quarter*, 31.

Drechsler, I., A. Savov, and P. Schnabl (2018). A model of monetary policy and risk premia. *Journal of Finance 73*(1), 317–373.

Drechsler, I. and A. Yaron (2010). What's vol got to do with it. *Review of Financial Studies 24*(1), 1–45.

Eggertsson, G. and M. Woodford (2003). The zero bound on interest rates and optimal monetary policy. *Brookings Papers on Economic Activity 1*, 139–211.

Evans, C. L. (1998). Real-time taylor rules and the federal funds futures market. *Economic Perspectives 22*(3), 44–56.

Fiordelisi, F., G. Galloppo, and O. Ricci (2014). The effect of monetary policy interventions on interbank markets, equity indices and G-SIFIs during financial crisis. *Journal of Financial Stability 11*, 49–61.

Fisher, K. L. and M. Statman (2003). Consumer confidence and stock returns. *Journal of Portfolio Management 30*(1), 115–127.

Florackis, C., A. Kontonikas, and A. Kostakis (2014). Stock market liquidity and macro-liquidity shocks: Evidence from the 2007–2009 financial crisis. *Journal of International Money and Finance 44*, 97–117.

Garcia, D. (2013). Sentiment during recessions. *Journal of Finance 68*(3), 1267–1300.

Gertler, M. and P. Karadi (2015). Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics 7*(1), 44–76.

Gervais, S. and T. Odean (2001). Learning to be overconfident. *Review of Financial Studies 14*(1), 1–27.

Greenspan, A. (2008). *The age of turbulence: Adventures in a new world*. Penguin.

Grinblatt, M. and M. Keloharju (2001). What makes investors trade? *Journal of Finance 56*(2), 589–616.

Gürkaynak, 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 1*(1), 55–93.

Gürkaynak, R. S., B. P. Sack, and E. T. Swanson (2007). Market-based measures of monetary policy expectations. *Journal of Business & Economic Statistics 25*(2), 201–212.

Huang, D., F. Jiang, J. Tu, and G. Zhou (2015). Investor sentiment aligned: A powerful predictor of stock returns. *Review of Financial Studies 28*(3), 791–837.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica 82*(2), 463–505.

Kahneman, D. (1979). Econ ometrica i ci. *Econometrica 47*(2), 263–291.

Kaplanski, G., H. Levy, C. Veld, and Y. Veld-Merkoulova (2015). Do happy people make optimistic investors? *Journal of Financial and Quantitative Analysis 50*(1-2), 145–168.

Kontonikas, A., R. MacDonald, and A. Saggu (2013). Stock market reaction to fed funds rate surprises: State dependence and the financial crisis. *Journal of Banking and Finance 37*(11), 4025–4037.

Kumar, A. and C. Lee (2006). Retail investor sentiment and return comovements. *Journal of Finance 61*(5), 2451–2486.

Kurov, A. (2010). Investor sentiment and the stock market's reaction to monetary policy. *Journal of Banking and Finance 34*(1), 139–149.

Kurov, A., A. Sancetta, G. Strasser, and M. Wolfe (2017). Price drift before US macroeconomic news: Private information about public announcements? *Journal of Financial and Quantitative Analysis Forthcoming*.

Kuttner, K. N. (2001). Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. *Journal of Monetary Economics 47*(3), 523–544.

Kuttner, K. N. (2003). Dating changes in the federal funds rate. Working Paper 1989-92, Oberlin College.

Lamont, O. A. and J. C. Stein (2004). Aggregate short interest and market valuations. *American Economic Review 94*(2), 29–32.

Lee, C., A. Shleifer, and R. H. Thaler (1991). Investor sentiment and the closed-end fund puzzle. *Journal of Finance 46*(1), 75–109.

Lemmon, M. and E. Portniaguina (2006). Consumer confidence and asset prices: Some empirical evidence. *Review of Financial Studies 19*(4), 1499–1529.

Lerner, J. S. and D. Keltner (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition & emotion 14*(4), 473–493.

Lian, C., Y. Ma, and C. Wang (2018, 09). Low Interest Rates and Risk-Taking: Evidence from Individual Investment Decisions.

Lioui, A. and P. Maio (2014). Interest rate risk and the cross section of stock returns. *Journal of Financial and Quantitative Analysis 49*(02), 483–511.

Lucca, D. O. and E. Moench (2015). The pre-FOMC announcement drift. *Journal of Finance 70*(1), 329–371.

Lutz, C. (2015). The impact of conventional and unconventional monetary policy on investor sentiment. *Journal of Banking and Finance 61*, 89–105.

MacKinlay, A. C. (1997). Event studies in economics and finance. *Journal of Economic Literature 35*(1), 13–39.

Maio, P. F. (2014). Another look at the stock return response to monetary policy actions. *Review of Finance 18*(1), 321–371.

McLean, R. D. and M. Zhao (2014). The business cycle, investor sentiment, and costly external finance. *Journal of Finance 69*(3), 1377–1409.

Mian, G. M. and S. Sankaraguruswamy (2012). Investor sentiment and stock market response to earnings news. *Accounting Review 87*(4), 1357–1384.

Miller, E. M. (1977). Risk, uncertainty, and divergence of opinion. *Journal of Finance 32*(4), 1151–1168.

Neuhierl, A. and M. Weber (2017). Monetary momentum. Cesifo working paper series no. 6648.

Ortony, A., G. L. Clore, and A. Collins (1990). *The cognitive structure of emotions*. Cambridge university press.

Ozdagli, A. and M. Weber (2017). Monetary policy through production networks: Evidence from the stock market. Technical report, National Bureau of Economic Research.

Ozdagli, A. K. (2017). Financial frictions and the stock price reaction to monetary policy. *Review of Financial Studies*.

Park, J. and M. R. Banaji (2000). Mood and heuristics: The influence of happy and sad states on sensitivity and bias in stereotyping. *Journal of Personality and Social Psychology 78*(6), 1005.

Peng, L. and W. Xiong (2006). Investor attention, overconfidence and category learning. *Journal of Financial Economics 80*(3), 563–602.

Perez-Quiros, G. and A. Timmermann (2000). Firm size and cyclical variations in stock returns. *Journal of Finance 55*(3), 1229–1262.

Piazzesi, M. and E. T. Swanson (2008). Futures prices as risk-adjusted forecasts of monetary policy. *Journal of Monetary Economics 55*(4), 677–691.

Ricci, O. (2015). The impact of monetary policy announcements on the stock price of large European banks during the financial crisis. *Journal of Banking and Finance 52*, 245–255.

Rigobon, R. and B. Sack (2004). The impact of monetary policy on asset prices. *Journal of Monetary Economics 51*(8), 1553–1575.

Romer, C. D. and D. H. Romer (2004). A new measure of monetary shocks: Derivation and implications. *American Economic Review 94*(4), 1055–1084.

Rosa, C. (2012). How"unconventional" are large-scale asset purchases? The impact of monetary policy on asset prices. Working Paper 560, Federal Reserve Bank of New York Staff.

Rosen, R. (2006). Merger momentum and investor sentiment: The stock market reaction to merger announcements. *Journal of Business 79*(2), 987–1017.

Shleifer, A. (2000). *Inefficient Markets: An Introduction to Behavioural Finance*. Oxford University Press.

Shleifer, A. and R. W. Vishny (1997). The limits of arbitrage. *Journal of Finance 52*(1), 35–55.

Stambaugh, R. F., J. Yu, and Y. Yuan (2012). The short of it: Investor sentiment and anomalies. *Journal of Financial Economics 104*(2), 288–302.

Stambaugh, R. F., J. Yu, and Y. Yuan (2014). The long of it: Odds that investor sentiment spuriously predicts anomaly returns. *Journal of Financial Economics 114*(3), 613–619.

Swanson, E. T. (2015). Measuring the effects of unconventional monetary policy on asset prices. Working Paper 21816, National Bureau of Economic Research.

Thornton, D. L. (2014). The identification of the response of interest rates to monetary policy actions using market-based measures of monetary policy shocks. *Oxford Economic Papers 66*(1), 67–87.

Tiedens, L. Z. and S. Linton (2001). Judgment under emotional certainty and uncertainty: The effects of specific emotions on information processing. *Journal of Personality and Social Psychology 81*(6), 973.

Tversky, A. and D. Kahneman (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty 5*(4), 297–323.

Welsch, R. E. and E. Kuh (1977). Linear regression diagnostics. Discussion paper.

Wright, J. H. (2012). What does monetary policy do to long-term interest rates at the zero lower bound? *Economic Journal 122*(564), F447–F466.

Yu, J. and Y. Yuan (2011). Investor sentiment and the mean–variance relation. *Journal of Financial Economics 100*(2), 367–381.

Yuan, Y. (2015). Market-wide attention, trading, and stock returns. *Journal of Financial Economics 116*(3), 548–564.

Table 1: Descriptive statistics for FFR changes, unexpected changes and path surprises

Δi_t and Δi_t^u denote FFR target rate changes and unexpected changes, respectively, on scheduled and unscheduled FOMC meetings over June 1989 - October 2014, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. $path_t$ denotes path surprises on scheduled FOMC meetings over January 2009 - October 2014.

	Obs	Min	Max	Mean	St.Dev.
Panel A: All meetings					
Δi_t	228	-0.75	0.75	-0.04	0.21
Δi_t^u	228	-0.42	0.17	-0.02	0.08
$path_t$	47	-0.62	0.46	-0.01	0.15
Panel B: Contractionary					
$\Delta i_t > 0$	31	0.25	0.75	0.30	0.12
$\Delta i_t^u > 0$	53	0.003	0.17	0.05	0.04
$path_t > 0$	17	0.003	0.46	0.10	0.14
Panel C: Expansionary					
$\Delta i_t < 0$	51	-0.75	-0.25	-0.34	0.14
$\Delta i_t^u < 0$	88	-0.42	-0.004	-0.09	0.09
$path_t < 0$	30	-0.62	-0.002	-0.08	0.12
Panel D: No change					
Δi_t=0	146	0.00	0.00	0.00	0.00
$\Delta i_t^u = 0$	87	0.00	0.00	0.00	0.00
$path_t = 0$	0				

Table 2: LSAPs and liquidity facilities announcements

This table summarizes announcements of expansionary nature by the Fed that reflect the initiation or continuation of Large Scale Asset Purchases (LSAPs) and liquidity facilities programmes. The liquidity facilities provided by the Fed incorporated, among other programmes, central bank liquidity swaps and the term auction facility (TAF). The source of the data is the Federal Reserve website (https://www.federalreserve.gov/monetarypolicy/).

Announcement	Obs	Date of first announcement	Date of last announcement
Liquidity facilities	46	12/12/2007	31/10/2013
Central bank liquidity swaps	13	12/12/2007	31/10/2013
Term auction facility	13	12/12/2007	28/08/2009
Other liquidity facilities	21	03/11/2008	04/12/2009
LSAPs	22	25/11/2008	30/10/2013

Table 3: Correlation matrix

This table presents correlation coefficients of the sentiment-based states, along with the business cycle indicator and FFR surprises. $S_t^{H,i}$ is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. i = CSI, CCI and BWI; where CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. $S_t^{D,i}$ is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. $S_t^{HD,i}$ is a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. i = CSI and CCI. $NBER_t$ is a dummy variable that is equal to 1 if the FOMC meeting occurred during a U.S. recession as classified by NBER business cycle dates and 0 otherwise. Δi_t^u denotes unexpected FFR changes. The sample includes scheduled and unscheduled FOMC meetings over June 1989 - October 2014, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	$S_t^{H,CSI}$	$S_t^{D,CSI}$	$S_t^{HD,CSI}$	$S_t^{H,CCI}$	$S_t^{D,CCI}$	$S_t^{HD,CCI}$	$S_t^{H,BWI}$	$NBER_t$	Δi_t^u
$S_t^{H,CSI}$	1.00								
$S_t^{D,CSI}$	0.17**	1.00							
$S_t^{HD,CSI}$	0.65***	0.67***	1.00						
$S_t^{H,CCI}$	0.81***	0.27***	0.66***	1.00					
$S_t^{D,CCI}$	0.17***	0.86***	0.53***	0.41***	1.00				
$S_t^{HD,CCI}$	0.65***	0.53***	0.85***	0.80***	0.67***	1.00			
$S_t^{H,BWI}$	0.59***	0.19***	0.55***	0.49***	0.05	0.41***	1.00		
$NBER_t$	-0.07	0.37***	0.11	0.02	0.37***	0.11	0.05	1.00	
Δi_t^u	0.05	−0.14**	-0.03	-0.02	−0.14**	-0.03	0.01	−0.19***	1.00

Table 4: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment

Panel A of this table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)\Delta i_t^u+\beta_2 S_t^H \Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP market returns (value-weighed and equally-weighted, alternatively) in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. Panel B of this table replaces S_t^H in the above equation with S_t^D, a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. Panel C of this table replaces S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

		Value weighted returns				Equally weighted returns			
	Obs	β_0	β_1	β_2	$Adj.R^2$	β_0	β_1	β_2	$Adj.R^2$
Panel A: S_t^H									
CSI	181	0.21**	-0.38	−7.17***	0.14	0.16**	-0.64	−4.65**	0.10
		(0.09)	(0.99)	(2.20)		(0.07)	(0.66)	(2.11)	
CCI	181	0.20**	-0.53	−7.37***	0.14	0.15**	-0.57	−4.95**	0.11
		(0.09)	(0.95)	(2.29)		(0.07)	(0.63)	(2.17)	
BWI	181	0.23**	-0.38	−6.82***	0.14	0.17***	0.44	−5.48***	0.15
		(0.09)	(1.02)	(2.19)		(0.06)	(0.83)	(1.77)	
Panel B: S_t^D									
CSI	181	0.20**	-0.68	−5.00**	0.10	0.15**	-0.81	−3.37*	0.07
		(0.09)	(1.26)	(2.19)		(0.07)	(0.80)	(1.71)	
CCI	181	0.20**	-0.77	−4.97**	0.09	0.15**	-0.86	−3.35*	0.07
		(0.09)	(1.27)	(2.01)		(0.07)	(0.80)	(1.72)	
Panel C: S_t^{HD}									
CSI	181	0.21**	-0.21	−8.25***	0.17	0.16**	-0.38	−5.50**	0.12
		(0.09)	(0.94)	(2.27)		(0.07)	(0.63)	(2.23)	
CCI	181	0.21**	-0.25	−8.21***	0.17	0.16**	-0.40	−5.48**	0.12
		(0.09)	(0.94)	(2.28)		(0.07)	(0.61)	(2.24)	

Table 5: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - 2-day and 3-day cumulative returns

This table presents OLS estimates with heteroscedasticity-consistent standard errors of the following model: $R_{t,t+1}=\beta_0+\beta_1(1-S_t^H)\Delta i_t^u+\beta_2 S_t^H \Delta i_t^u+\varepsilon_t$, where $R_{t,t+1}$ and Δi_t^u denote CRSP value weighted market returns in excess of the 1-month Treasury bill rate accumulated over two days (FOMC announcement day and the following day) and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. We also replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Panel B replaces 2-day cumulative returns with 3-day (FOMC announcement day and the following 2 days) cumulative returns, that is, $R_{t,t+2}$. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$	β_0	β_1	β_2	$Adj.R^2$
			S_t^H				S_t^{HD}		
Panel A: 2-day returns									
CSI	181	0.28**	-1.91	−7.77***	0.08	0.28**	-1.50	−9.04***	0.10
		(0.12)	(1.51)	(2.73)		(0.12)	(1.41)	(2.89)	
CCI	181	0.27**	-1.81	−8.21***	0.09	0.28**	-1.57	−8.97***	0.10
		(0.12)	(1.45)	(2.80)		(0.12)	(1.41)	(2.90)	
BWI	181	0.29**	-1.96	−7.41***	0.08				
		(0.12)	(1.52)	(2.69)					
Panel B: 3-day returns									
CSI	181	0.34**	-1.83	−5.51*	0.03	0.34**	-1.57	−6.31*	0.03
		(0.14)	(2.03)	(3.22)		(0.14)	(1.88)	(3.55)	
CCI	181	0.33**	-1.89	−5.64*	0.03	0.34**	-1.57	−6.33*	0.03
		(0.14)	(1.94)	(3.38)		(0.14)	(1.88)	(3.56)	
BWI	181	0.34**	-2.23	-4.92	0.02				
		(0.14)	(2.09)	(3.16)					

Table 6: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - accounting for policy asymmetry

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)\Delta i_t^{un}+\beta_2(1-S_t^H)\Delta i_t^{up}+\beta_3 S_t^H\Delta i_t^{un}+\beta_4 S_t^H\Delta i_t^{up}+\varepsilon_t$, where R_t, Δi_t^{un} and Δi_t^{up} denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate, negative unexpected FFR changes and positive unexpected FFR changes, respectively. Negative FFR surprises are calculated as $\Delta i_t^{un}=\Delta i_t^u D_t^n$, where D_t^n is a dummy variable that is equal to 1 if $\Delta i_t^u<0$, and 0 otherwise. Positive FFR surprises are calculated as $\Delta i_t^{up}=\Delta i_t^u D_t^p$, where D_t^p is a dummy variable that is equal to 1 if $\Delta i_t^u>0$, and 0 otherwise. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$
Panel A: S_t^H							
CSI	181	0.01	-1.22	-0.70	-10.15^{***}	6.83	0.22
		(0.09)	(0.94)	(4.57)	(1.67)	(6.27)	
CCI	181	0.02	-1.29	0.37	-10.10^{***}	9.44	0.22
		(0.09)	(0.94)	(3.77)	(1.67)	(6.84)	
BWI	181	0.03	-1.70	6.34	-9.54^{***}	2.41	0.19
		(0.09)	(1.04)	(6.21)	(1.84)	(5.35)	
Panel B: S_t^{HD}							
CSI	181	0.05	-1.08	1.50	-10.52^{***}	7.05	0.23
		(0.09)	(0.93)	(3.75)	(1.68)	(8.31)	
CCI	181	0.06	-1.10	1.30	-10.50^{***}	7.37	0.23
		(0.09)	(0.93)	(3.74)	(1.68)	(8.24)	

Table 7: Pre-ZLB response of aggregate market risk aversion to FFR shocks conditional upon the state of investor sentiment

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $\Delta VRP_t = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^u + \beta_2 S_t^H \Delta i_t^u + \varepsilon_t$, where ΔVRP_t denotes the daily change in the S&P 500 Variance Risk Premium (VRP). Δi_t^u denotes the unexpected FFR changes. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. Panel B of this table replaces S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
Panel A: S_t^H					
CSI	172	-0.12^{***}	0.10	0.92^{*}	0.01
		(0.04)	(0.43)	(0.50)	
CCI	172	-0.12^{***}	0.04	1.05^{**}	0.01
		(0.04)	(0.43)	(0.51)	
BWI	172	-0.12^{***}	-0.48^{*}	1.31^{**}	0.04
		(0.04)	(0.28)	(0.55)	
Panel B: S_t^{HD}					
CSI	172	-0.12^{***}	-0.06	1.27^{**}	0.02
		(0.04)	(0.42)	(2.26)	
CCI	172	-0.12^{***}	-0.07	1.28^{**}	0.02
		(0.04)	(0.42)	(0.54)	

Table 8: Pre-ZLB response of stock market returns and aggregate market risk aversion to FFR shocks conditional upon the state of investor sentiment - controlling for the monetary policy cycle

Panel A of this table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)(1-Eas_t)\Delta i_t^u+\beta_2(1-S_t^H)Eas_t\Delta i_t^u+\beta_3 S_t^H(1-Eas_t)\Delta i_t^u+\beta_4 S_t^H Eas_t\Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. Panel B of this table replaces R_t with ΔVRP, the daily change in the S&P 500 Variance Risk Premium (VRP). We also replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Eas_t is a dummy variable that captures the state of the monetary cycle, being equal to 1 if the FOMC meeting occurred during a monetary easing cycle and 0 otherwise. A monetary easing cycle is defined as starting with a negative FFR target rate change and ending with a positive FFR target rate change. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$
		S_t^H						S_t^{HD}					
Panel A: Stock market returns													
CSI	181	0.21**	-1.59	-0.12	0.21	−7.73***	0.15	0.21**	-0.72	-0.09	-4.18	−8.40***	0.16
		(0.09)	(2.28)	(1.07)	(4.49)	(2.27)		(0.09)	(2.20)	(1.02)	(5.32)	(2.36)	
CCI	181	0.19**	-1.64	-0.31	0.48	−7.99***	0.15	0.21**	-0.89	-0.12	-2.81	−8.43***	0.16
		(0.10)	(2.27)	(1.04)	(4.61)	(2.37)		(0.10)	(2.21)	(1.02)	(5.13)	(2.37)	
BWI	181	0.19**	11.37	-0.69	-1.95	−8.47***	0.16						
		(0.10)	(7.70)	(1.04)	(2.02)	(2.54)							
Panel B: Aggregate market risk aversion													
CSI	172	−0.12***	1.99	-0.36	-1.54	1.10**	0.03	−0.12***	1.48	−0.46*	-2.17	1.41**	0.04
		(0.03)	(1.76)	(0.23)	(1.94)	(0.51)		(0.03)	(1.51)	(0.27)	(3.25)	(0.56)	
CCI	172	−0.12***	2.03	-0.41	-1.82	1.27**	0.04	−0.12***	1.49	−0.46*	-2.11	1.42**	0.04
		(0.03)	(1.74)	(0.27)	(2.00)	(0.53)		(0.03)	(1.51)	(0.27)	(3.25)	(0.56)	
BWI	172	−0.12***	−4.46*	-0.40	1.43	1.28**	0.04						
		(0.03)	(2.27)	(0.27)	(1.43)	(0.52)							

Table 9: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - controlling for the business cycle

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)(1-Rec_t)\Delta i_t^u+\beta_2(1-S_t^H)Rec_t\Delta i_t^u+\beta_3 S_t^H(1-Rec_t)\Delta i_t^u+\beta_4 S_t^H Rec_t\Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. We also replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Rec_t is a variable that captures the state of the economy, measured by the NBER business cycle chronology and the real time probability of recession. Specifically, $NBER_t$ is a dummy variable that is equal to 1 if the FOMC meeting occurred during a U.S. recession as classified by NBER business cycle dates and 0 otherwise. $Recprob_t$ is equal to the real time recession probability when the FOMC meeting takes place, obtained from the dynamic-factor Markov-Switching model of Chauvet and Piger (2008). The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$
				S_t^H							S_t^{HD}		
Panel A: NBER recession													
CSI	181	0.21**	-0.84	0.66	−8.32***	-5.21	0.14	0.21**	-0.55	0.65	−10.41***	-5.21	0.18
		(0.09)	(1.24)	(1.17)	(2.17)	(4.37)		(0.09)	(1.15)	(1.17)	(1.91)	(4.37)	
CCI	181	0.20**	-1.01	0.61	−8.70***	-5.24	0.14	0.21**	-0.61	0.66	−10.36***	-5.21	0.18
		(0.09)	(1.19)	(1.17)	(2.24)	(4.38)		(0.09)	(1.15)	(1.17)	(1.92)	(4.37)	
BWI	181	0.23**	-0.89	0.75	−7.73***	-5.16	0.13						
		(0.09)	(1.32)	(1.17)	(2.32)	(4.36)							
Panel B: Recession Probability													
CSI	181	0.21**	-0.87	1.78	−7.59***	-6.16	0.14	0.21**	-0.56	1.51	−10.27***	-4.24	0.17
		(0.09)	(1.26)	(2.29)	(2.51)	(7.91)		(0.09)	(1.17)	(2.26)	(2.82)	(7.99)	
CCI	181	0.20**	-1.03	1.81	−8.00***	-5.93	0.14	0.21**	-0.62	1.57	−10.20***	-4.28	0.17
		(0.09)	(1.21)	(2.29)	(2.71)	(7.95)		(0.09)	(1.17)	(2.26)	(2.84)	(8.00)	
BWI	181	0.23**	-0.91	1.85	−6.90***	-6.62	0.13						
		(0.09)	(1.35)	(2.31)	(2.52)	(7.88)							

Table 10: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - corrected for joint-response bias

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over the pre-zero lower bound (ZLB) sample period, June 1989 - December 2008 (daily data), of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)FOMC_t+\beta_2(1-S_t^H)\Delta i_t^u+\beta_3(1-S_t^H)FOMC_t\Delta i_t^u+\beta_4 S_t^H FOMC_t+\beta_5 S_t^H\Delta i_t^u+\beta_6 S_t^H FOMC_t\Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. $FOMC_t$ is dummy variable that is equal to 1 on FOMC announcement days and 0 otherwise. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	β_4	β_5	β_6
Panel A: S_t^H								
CSI	4927	0.01	-0.08	-0.61^{*}	-0.37	0.33^{***}	1.83^{**}	-7.65^{***}
		(0.02)	(0.16)	(0.32)	(1.31)	(0.11)	(0.72)	(2.49)
CCI	4927	0.01	0.10	-0.60^{*}	0.06	0.30^{**}	1.91^{**}	-7.91^{***}
		(0.02)	(0.12)	(0.31)	(1.12)	(0.13)	(0.75)	(2.65)
BWI	4927	0.01	0.16	-0.49^{*}	0.17	0.30^{**}	1.89^{**}	-7.95^{***}
		(0.02)	(0.11)	(0.29)	(1.14)	(0.14)	(0.78)	(2.58)
Panel B: S_t^{HD}								
CSI	4927	0.01	-0.13	-0.66^{**}	0.47	0.35^{**}	2.36^{***}	-9.17^{***}
		(0.02)	(0.10)	(0.29)	(1.08)	(0.16)	(0.88)	(2.69)
CCI	4927	0.01	0.15	-0.69^{**}	0.50	0.33^{**}	2.49^{***}	-9.33^{***}
		(0.02)	(0.10)	(0.29)	(1.08)	(0.16)	(0.93)	(2.71)

Table 11: Pre-ZLB intraday response of stock market returns to FFR shocks conditional upon the state of investor sentiment

Panel A of this table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)\Delta i_t^u+\beta_2 S_t^H \Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote log returns on the S&P500 index in excess of the 1-month Treasury bill rate, and unexpected FFR changes. Both aforementioned variables are calculated using intrady data and windows surrounding FOMC announcements. When the embargo period is included, the relevant windows are: 30-mins (-10,20) and 120-mins (-10,110), respectively. When the embargo period is excluded, the relevant windows are: 21-mins (-1,20) and 111-mins (-1,110), respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. Panel B of this table replaces S_t^H in the above equation with S_t^D, a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. Panel C of this table replaces S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over February 1995 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	All meetings									Scheduled meetings only								
	(-10, 20)					(-1, 20)				(-10, 20)					(-1, 20)			
	Obs	β_0	β_1	β_2	$Adj.R^2$	β_0	β_1	β_2	$Adj.R^2$	Obs	β_0	β_1	β_2	$Adj.R^2$	β_0	β_1	β_2	$Adj.R^2$
Panel A: S_t^H																		
CCI	117	-0.16^{***}	-0.01	-7.06^{***}	0.50	-0.14^{***}	-1.38	-7.14^{***}	0.43	112	-0.16^{***}	-0.01	-4.46^{***}	0.18	-0.16^{***}	-1.26	-4.83^{***}	0.18
		(0.04)	(0.88)	(1.26)		(0.05)	(1.12)	(1.45)		112	(0.04)	(0.87)	(1.33)		(0.04)	(1.10)	(1.47)	
BWI	117	-0.16^{***}	-0.33	-7.16^{***}	0.50	-0.14^{***}	-1.64	-7.18^{***}	0.43	112	-0.16^{***}	-0.35	-4.58^{***}	0.18	-0.16^{***}	-1.54	-4.88^{***}	0.18
		(0.05)	(2.16)	(1.24)		(0.05)	(2.21)	(1.46)		112	(0.04)	(2.16)	(1.37)		(0.04)	(2.21)	(1.49)	
Panel B: S_t^{HD}																		
CSI	117	-0.14^{***}	-1.93	-7.31^{***}	0.51	-0.13^{***}	-3.10^{*}	-7.20^{***}	0.43	112	-0.15^{***}	-1.95	-4.72^{***}	0.18	-0.15^{***}	-3.15^{*}	-4.75^{***}	0.17
		(0.04)	(1.27)	(1.28)		(0.05)	(1.69)	(1.50)		112	(0.04)	(1.29)	(1.55)		(0.04)	(1.73)	(1.61)	
CCI	117	-0.14^{***}	-1.64	-7.34^{***}	0.51	-0.13^{***}	-2.93^{*}	-7.21^{***}	0.43	112	-0.15^{***}	-1.65	-4.80^{***}	0.18	-0.15^{***}	-2.97^{*}	-4.80^{***}	0.17
		(0.04)	(1.29)	(1.28)		(0.05)	(1.70)	(1.50)		112	(0.04)	(1.30)	(1.55)		(0.04)	(1.73)	(1.61)	

Table 12: ZLB response of stock market returns to path surprises conditional upon the state of investor sentiment

Panel A of this table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t = \beta_0 + \beta_1(1 - S_t^D)path_t + \beta_2 S_t^D path_t + \varepsilon_t$, where R_t and $path_t$ denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and path surprises, respectively. S_t^D is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. CSI denotes the University of Michigan's Consumer Sentiment index. The zero lower bound (ZLB) sample period includes scheduled FOMC meetings over January 2009 - October 2014. Panel B of this table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC meeting days, of the following model: $R_t = \beta_0 + \beta_1(1 - S_t^D)path_t^n + \beta_2(1 - S_t^D)path_t^p + \beta_3 S_t^D path_t^n + \beta_4 S_t^D path_t^p + \varepsilon_t$, where $path_t^n$ and $path_t^p$ denote negative and positive path surprises, respectively. Negative path surprises are calculated as $path_t^n = path_t D_t^n$, where D_t^n is a dummy variable that is equal to 1 if $path_t < 0$, and 0 otherwise. Positive path surprises are calculated as $path_t^p = path_t D_t^p$, where D_t^p is a dummy variable that is equal to 1 if $path_t > 0$, and 0 otherwise. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$
				Panel A			
CSI	47	0.25	0.49	-4.59^{***}			0.12
		(0.17)	(0.72)	(1.56)			
				Panel B			
CSI	47	0.37	3.25	-0.02	-3.85^{**}	-7.51^{**}	0.09
		(0.25)	(4.57)	(0.96)	(1.45)	(3.45)	

Table 13: Response of stock market returns to LSAPs and liquidity facilities announcements conditional upon the state of investor sentiment

This table presents the CRSP value-weighted cumulative average abnormal returns (CAARs (%)) using alternative event windows across periods of decreasing sentiment (Panel A) and increasing sentiment (Panel B). Returns are in excess of the 1-month Treasury bill rate. Abnormal returns are calculated using the constant mean model and a 20-day estimation period that ends prior to the event window. We consider announcements by the Fed over the period December 2007 - October 2014 that reflect the initiation/continuation or slowdown/stop of Large Scale Asset Purchases (LSAPs) and liquidity facilities programmes. There are 46 announcements related to liquidity facilities (LIQ_{all}), including 13 announcements about central bank liquidity swaps (CB swaps), 13 announcements about the term auction facility (TAF) and 21 announcements about other liquidity facilities (Other). 22 LSAPs-related announcements are also considered. A year is defined as of decreasing (increasing) sentiment if the University of Michigan's Consumer Sentiment index at the end (December) of that year is lower (higher) than at the end of the previous year. The statistical significance of CAARs is evaluated using the Boehmer, Masumeci, and Poulsen (1991) test statistic that accounts for event-induced increase in returns volatility. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Event window	CB swaps	TAF	Other	LIQ_{all}	LSAPs	LIQ_{all}+LSAPs
Panel A: Decreasing sentiment						
(-1, 3)	3.17	-1.92	-0.74	-0.14	1.49	-0.05
(-1, 1)	3.11**	-0.74	0.10	0.55	1.87	0.47
(0, 0)	1.51***	-0.42	-0.06	0.16	0.08	0.12
Panel B: Increasing sentiment						
(-1, 3)	0.77			0.77	-0.64	-0.36
(-1, 1)	0.22			0.22	-0.42	0.30
(0, 0)	0.96			0.96	-0.04	0.16

Figure 1: Actual and unexpected FFR changes

This figure plots actual (bar) and unexpected FFR changes (solid line) in percentage points on scheduled and unscheduled FOMC meetings over June 1989 - October 2014. Shaded areas denote U.S recessions as classified by NBER business cycle dates.

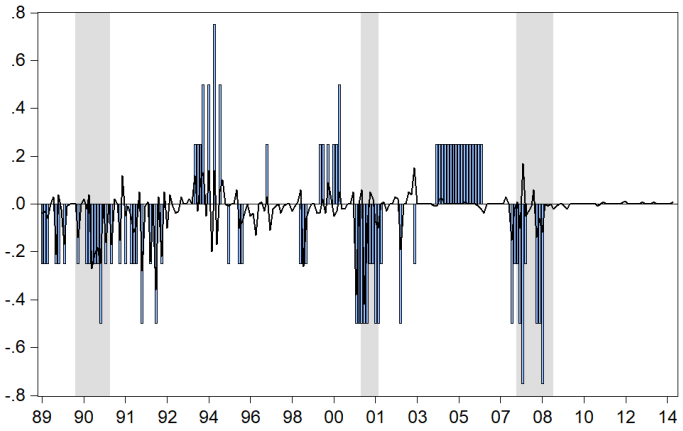


Figure 2: Orthogonalized sentiment indices

This figure plots sentiment indices using monthly data over the period June 1989 - October 2014. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Shaded areas denote the U.S recessions as classified by NBER business cycle dates.

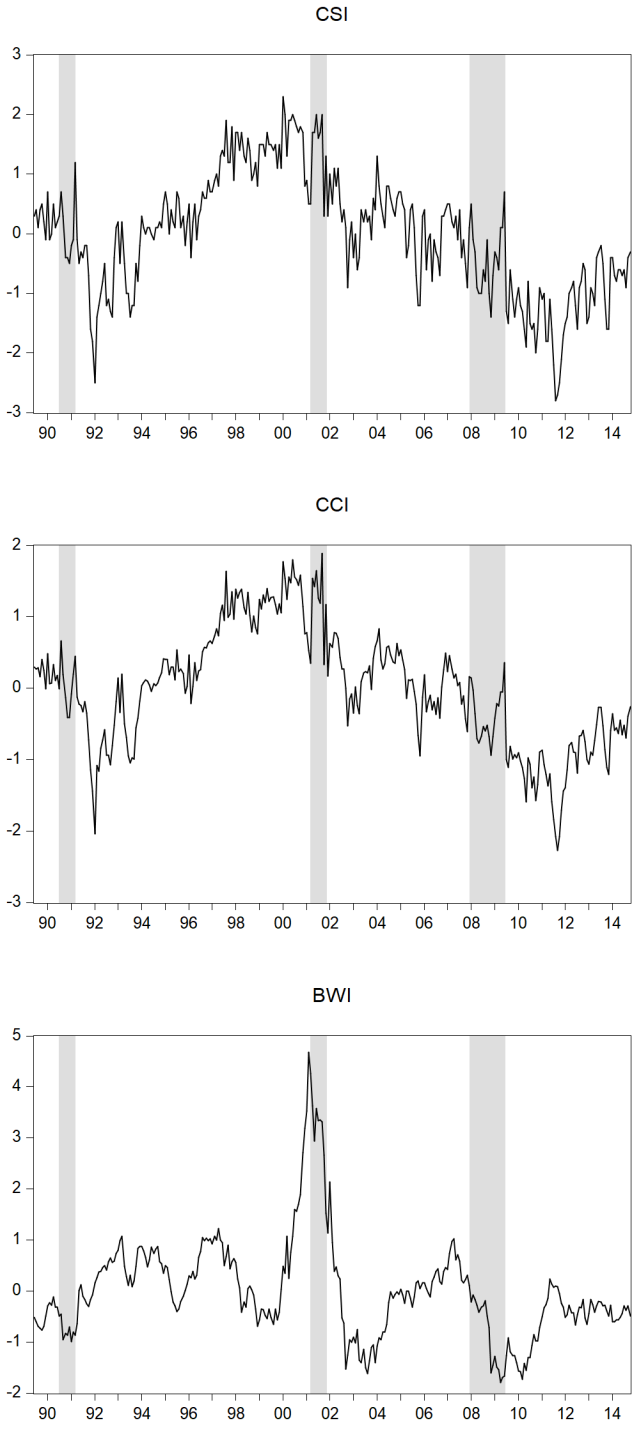


Figure 3: Sentiment level-based states

This figure plots level-based sentiment states, as captured by $S_t^{H,i}$, on scheduled and unscheduled FOMC meetings over June 1989 - October 2014, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. This dummy variable is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. i = CSI, CCI and BWI; where CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Shaded areas denote the U.S recessions as classified by NBER business cycle dates.

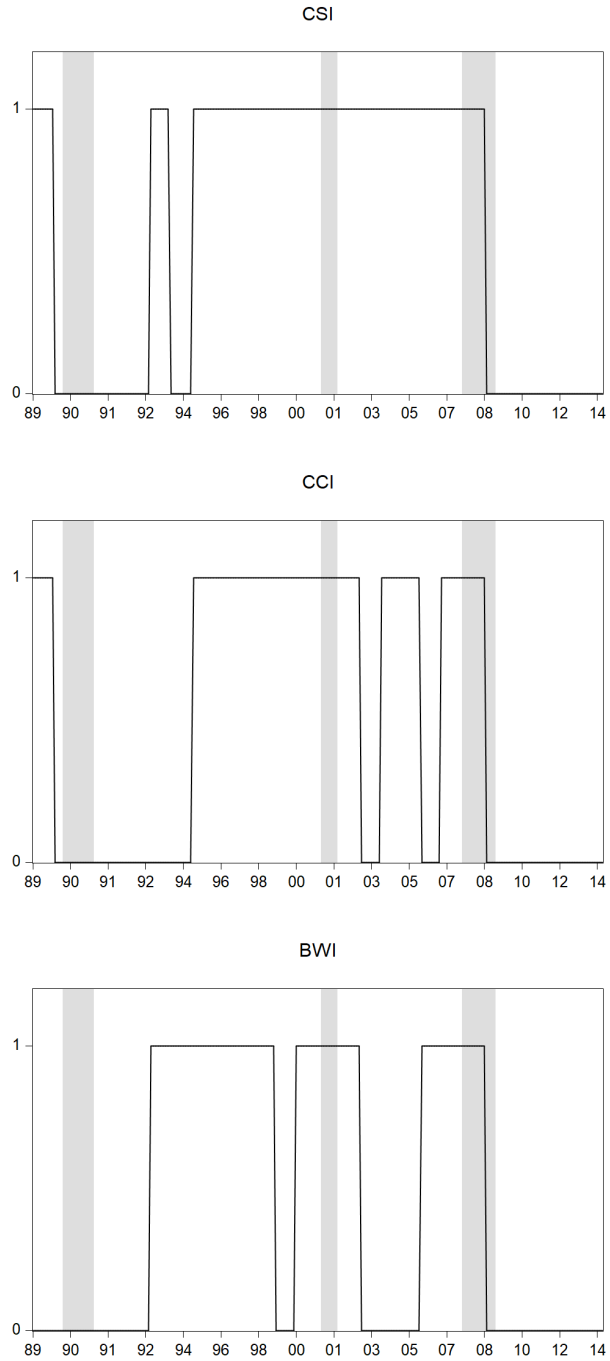


Figure 4: Sentiment changes-based states

This figure plots changes-based sentiment states, as captured by $S_t^{D,i}$ (the left hand panel) and $S_t^{HD,i}$ (the right hand panel), on scheduled and unscheduled FOMC meetings over June 1989 - October 2014, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings.. $S_t^{D,i}$ is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. $S_t^{HD,i}$ is a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. i = CSI and CCI; where CSI and CCI denote the University of Michigan's Consumer Sentiment index and the U.S. Consumer Confidence index, respectively. Shaded areas denote the U.S recessions as classified by NBER business cycle dates.

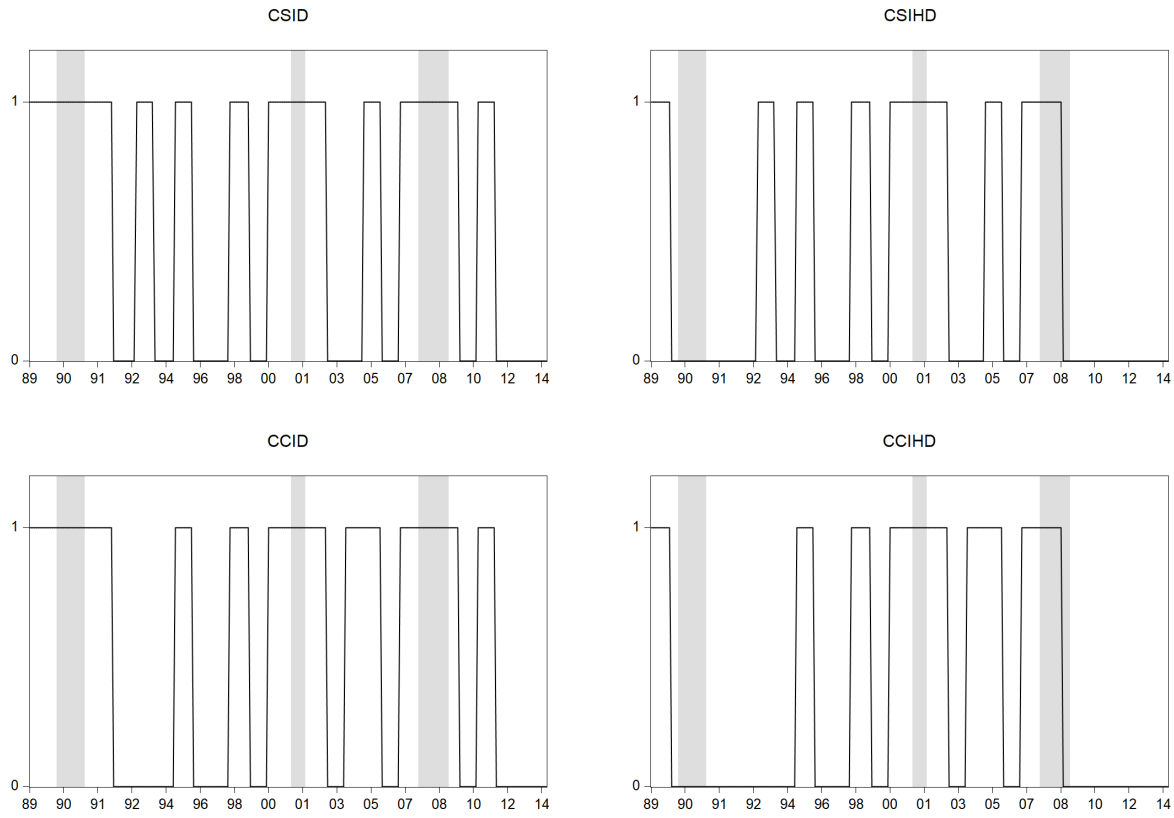


Figure 5: Sentiment states and bear markets

This figure plots level and changes-based interacted sentiment states (solid line), as captured by S_t^{HD}, along with a bear market indicator (dotted line), on scheduled and unscheduled FOMC meetings over June 1989 - October 2014, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. The sentiment dummy variable is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the CSI at the end (December) of the previous year exceeds the full sample mean value and the CSI at the end of that year is lower than at the end of the previous year. CSI denotes the University of Michigan's Consumer Sentiment index. The bear market indicator is a dummy variable that is equal to 1 when the S&P 500 stock market index is lower than its full sample 2-year moving average, and 0 otherwise. Shaded areas denote the U.S recessions as classified by NBER business cycle dates.

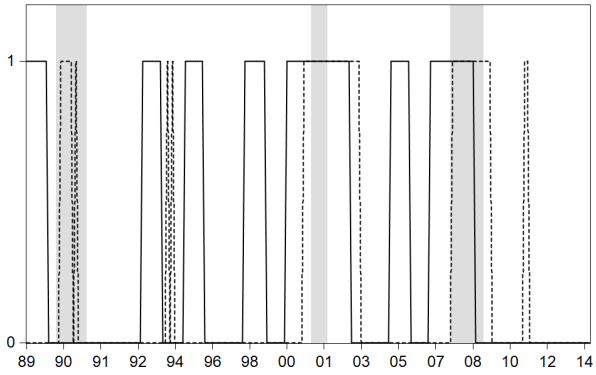
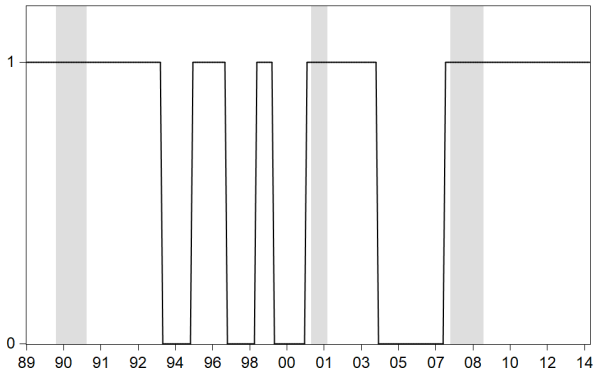


Figure 6: Monetary cycles

This figure plots monetary cycles, as captured by Eas_t, on scheduled and unscheduled FOMC meetings over June 1989 - October 2014, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. This dummy variable is equal to 1 if the FOMC meeting occurred during a monetary easing cycle and 0 otherwise. A monetary easing cycle is defined as starting with a negative FFR target rate change and ending with a positive FFR target rate change. Shaded areas denote the U.S recessions as classified by NBER business cycle dates.



Internet Appendix for "The Fed and the Stock Market: A Tale of Sentiment States"

March 28, 2019

Table A1: FOMC communication over time

This table lists key developments related to the evolution of the Fed's communication policy over the period June 1989 - October 2014. It also presents communication examples from FOMC statements. The source of the latter is the Federal Reserve website (http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm).

Prior to February 1994	No press releases regarding FOMC decisions. Market participants infer policy actions from the signals provided by the size and type of open market operations in the days following each FOMC meeting.
February 1994	Statement released on the day that the FOMC meeting is concluded to inform about policy action. No FOMC statement if policy rate remains unchanged. Statement does not refer to specific FFR value. 4 February 1994 statement: "The Federal Reserve Board today approved an increase in the discount rate from 4 3/4 percent to 5 1/4 percent, effective immediately. In a related move, the Federal Open Market Committee agreed that this increase should be reflected fully in interest rates in the reserve markets."
July 1995	FOMC statement includes reference to FFR value. 6 July 1995 statement: "Today's action will be reflected in a 25 basis point decline in the federal funds rate from about 6 percent to about 5-3/4 percent."
May 1999	Statement issued following each FOMC meeting, regardless of whether the FFR changed or not. 18 May 1999 statement: "While the FOMC did not take action today to alter the stance of monetary policy, the Committee was concerned about the potential for a buildup of inflationary imbalances that could undermine the favorable performance of the economy and therefore adopted a directive that is tilted toward the possibility of a firming in the stance of monetary policy."
June 1999	FOMC statement includes reference to FFR target. 30 June 1999 statement: "The Federal Open Market Committee today voted to raise its target for the federal funds rate 25 basis points to 5 percent."
March 2002	Statement includes the roll call of the vote on the FFR target.
December 2008	Zero lower bound and qualitative tone in forward guidance. 16 December 2008 statement: "The Federal Open Market Committee decided today to establish a target range for the federal funds rate of 0 to 1/4 percent....The Federal Reserve will employ all available tools to promote the resumption of sustainable economic growth and to preserve price stability. In particular, the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time."
August 2011	Date-based forward guidance. 9 August 2011 statement: "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."
December 2012	Threshold-based forward guidance, linking future policy decision to developments in unemployment and inflation. 12 December 2012 statement: "The Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent and 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."

Table A2: List of unscheduled FOMC meetings and meetings associated with employment report releases

This table presents the dates of unscheduled FOMC meetings and meetings associated with employment report releases, along with the corresponding CRSP value-weighted market returns in excess of the 1-month Treasury bill rate (R_t), the FFR target rate changes (Δi_t) and unexpected changes (Δi_t^u), over the period June 1989 - October 2014. All unscheduled meetings that were not accompanied by FOMC statement, or information about the FFR, are excluded.

Date	R_t	Δi_t	Δi_t^u	Employment	Unscheduled
05/06/1989	-0.87	-0.25	-0.04	No	Yes
07/07/1989	0.91	-0.25	-0.03	Yes	No
26/07/1989	1.00	-0.25	-0.06	No	Yes
16/10/1989	1.64	-0.25	-0.21	No	Yes
06/11/1989	-1.36	-0.25	0.04	Yes	Yes
13/07/1990	0.42	-0.25	-0.14	No	Yes
29/10/1990	-0.96	-0.25	-0.02	No	Yes
07/12/1990	-0.39	-0.25	-0.27	Yes	Yes
08/01/1991	-0.29	-0.25	-0.18	No	Yes
01/02/1991	-0.03	-0.50	-0.25	Yes	Yes
08/03/1991	-0.23	-0.25	-0.16	Yes	Yes
30/04/1991	0.18	-0.25	-0.17	No	Yes
06/08/1991	1.22	-0.25	-0.15	Yes	Yes
13/09/1991	-0.92	-0.25	-0.05	No	Yes
31/10/1991	0.09	-0.25	-0.05	No	Yes
06/12/1991	0.37	-0.25	-0.09	Yes	Yes
20/12/1991	0.99	-0.50	-0.28	No	Yes
09/04/1992	1.63	-0.25	-0.24	No	Yes
02/07/1992	-0.30	-0.50	-0.36	Yes	No
04/09/1992	-0.21	-0.25	-0.22	Yes	Yes
18/04/1994	-0.82	0.25	0.10	No	Yes
15/10/1998	4.06	-0.25	-0.26	No	Yes
03/01/2001	5.39	-0.50	-0.38	No	Yes
18/04/2001	3.92	-0.50	-0.42	No	Yes
17/09/2001	-5.03	-0.50	-0.32	No	Yes
10/08/2007	0.03	0.00	0.00	No	Yes
22/01/2008	-0.98	-0.75	-0.74	No	Yes
08/10/2008	-1.27	-0.50	-0.14	No	Yes

Table A3: Sentiment-waning phases and the state of the business and monetary cycle, aggregate market risk aversion, financial press references, and unscheduled meetings

This table lists sentiment-waning phases over the period June 1989 - October 2014. These phases are defined as years when the sentiment proxy (CSI) at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year ($S_t^{HD} = 1$). CSI denotes the University of Michigan's Consumer Sentiment index. Also, it shows whether sentiment waning phases overlap with U.S. recessions, as classified by NBER business cycle dates, and monetary policy easing cycles. The latter are defined as starting with a negative FFR target rate change and ending with a positive FFR target rate change. Market risk aversion peak years are defined as years when the annual average of the daily S&P 500 variance risk premium is higher than its mean plus one standard deviation (evaluated at the annual level). WJS "panic fear stock market" refer to the number of Wall Street Journal articles (per year), about the U.S. market, containing the aforementioned keywords (source Factiva). Finally, the unscheduled meetings occurring during sentiment correction phases are listed, along with relevant comments by the Fed Chair at the time.

Year	Recession	Monetary easing cycle	Market risk aversion peak	WSJ "panic fear stock market"	Unscheduled meetings
1989		June 1989 - December 1993		0	5 June, 26 July, 16 October, 6 November
1993		June 1989 - December 1993		56	
1995		July 1995 - February 1997		87	
1998		September 1998 - May 1999	Yes	147	15 October
2000				59	
2001	March 2001 - November 2001	January 2001 - May 2004		98	3 January, 18 April, 17 September
2002		January 2001 - May 2004	Yes	112	
2005				34	
2007	December 2007 - June 2009	September 2007 - October 2014		67	
2008	December 2007 - June 2009	September 2007 - October 2014	Yes	325	22 January, 8 October

	Comments by Fed Chair related to unscheduled meetings
October 1998	"The Russian default turned out to be the iceberg for this financial *Titanic*...The New York Fed, whose job is to help maintain order in Wall Street's markets tracked LTCM's death spiral...the **markets** were already **spooked and skittish**; Bill McDonough [President of New York Fed] worried that if a company of LTCM's size had to dump its assets on the market, prices would collapse... At a speaking engagement on October 7, after thirty-year treasury bonds hit their lower interest rates in thirty years...I told an audience of economists... **investors**...were **behaving irrationally**-paying substantially extra for the newest, most liquid treasury bonds, even though slightly older but less liquid ones were equally safe. This rush to liquidity was unprecedented...and reflected not judgement but **panic**. They basically are saying, 'I want out. I don't want to know anything about whether an investment is risky or not. I can't stand the pain. I just want out'...It took no argument at all to get the FOMC to lower interest rates. We did so three times in rapid succession, between September 29 and November 17...Gradually, as we'd hoped, the medicine took hold. The world's markets calmed down." (Greenspan, 2008; p.194-195)
January 2001	"The **deflation of the tech-stock bubble** had been the great financial drama of the preceding months. The NASDAQ lost a stunning 50 percent of its value between March [2001] and year-end...while the total losses were small in comparison with the paper wealth that the bull market had created, these were significant declines, and the **Wall Street outlook remained gloomy**, putting a **damper on public confidence**....the downturn was at the top of the agenda...**Sentiment**...**usually does not shift smoothly** from optimism to neutrality to gloom; it's like the bursting of a dam, in which a flood backs up until cracks appear and the dam is breached. The resulting torrent carries with it whatever shreds of confidence there were, and what remains is **fear**. We seemed to be confronting just such a breach....On the first business day of the New Year, we convened again via conference call and cut the fed funds rate by half a percentage point." (Greenspan, 2008; p206-207 & p.212-213)
October 2008	"The Federal Open Market Committee met by video conference late in the afternoon of Tuesday, October 7...I told the FOMC that the financial situation posed enormous and growing economic risks. A coordinated response, showing the resolve and cooperation of major central banks, could have a stronger effect on the U.S. and global economies than if we acted alone...The FOMC voted unanimously to cut the federal funds rate by a half percentage point, to 1-1/2 percent...Yet as dramatic as the coordinated rate cut was, it did not solve the global financial systems fundamental problems: **unremitting panic** and growing unease about the health of major financial institutions. The Dow Jones...rose 180 points after we announced the coordinated cuts but ended down 189 points, or 2 percent, for the day." (Bernanke, 2015; p.347-348)

Table A4: Pre-ZLB response of aggregate market risk aversion to FFR shocks conditional upon the state of investor sentiment - accounting for policy asymmetry

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $\Delta VRP_t = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^{un} + \beta_2(1 - S_t^H)\Delta i_t^{up} + \beta_3 S_t^H \Delta i_t^{un} + \beta_4 S_t^H \Delta i_t^{up} + \varepsilon_t$, where ΔVRP_t denotes the daily change in the S&P 500 Variance Risk Premium (VRP). Δi_t^{un} and Δi_t^{up} denote the negative unexpected FFR changes and positive unexpected FFR changes, respectively. Negative FFR surprises are calculated as $\Delta i_t^{un} = \Delta i_t^u D_t^n$, where D_t^n is a dummy variable that is equal to 1 if $\Delta i_t^u < 0$, and 0 otherwise. Positive FFR surprises are calculated as $\Delta i_t^{up} = \Delta i_t^u D_t^p$, where D_t^p is a dummy variable that is equal to 1 if $\Delta i_t^u > 0$, and 0 otherwise. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. Panel B of this table replaces S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 -December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	β_4	$Adj.R^2$
Panel A: S_t^H							
CSI	172	-0.10^{***}	-0.23	2.75	1.59^{***}	-2.51^{*}	0.08
		(0.03)	(0.22)	(2.50)	(0.54)	(1.39)	
CCI	172	-0.10^{***}	-0.22	1.71	1.57^{***}	-2.54^{*}	0.06
		(0.03)	(0.23)	(2.06)	(0.54)	(1.32)	
BWI	172	-0.11^{***}	-0.27	-2.24	1.39^{***}	1.17	0.04
		(0.03)	(0.24)	(1.95)	(0.48)	(2.07)	
Panel B: S_t^{HD}							
CSI	172	-0.11^{***}	-0.29	1.28	1.68^{***}	-1.88	0.05
		(0.03)	(0.23)	(2.02)	(0.60)	(1.43)	
BWI	172	-0.11^{***}	-0.30	1.28	1.69^{***}	-1.88csilag	0.05
		(0.03)	(0.23)	(2.01)	(0.60)	(1.44)	

Table A5: FOMC meetings with negative and positive FFR shocks across sentiment regimes

This table shows the number of FOMC meetings associated with negative and positive unexpected FFR changes across sentiment regimes over the full sample period (June 1989 - October 2014. Δi_t^u denotes unexpected FFR changes. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. S_t^D is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. S_t^{HD} is a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively.

		S_t^H	1-S_t^H	S_t^D	1-S_t^D	S_t^{HD}	1-S_t^{HD}
$\Delta i_t^u < 0$	CSI	55	33	58	30	36	52
	CCI	49	39	57	31	35	53
	BWI	48	40				
$\Delta i_t^u > 0$	CSI	32	21	29	24	22	31
	CCI	27	26	29	24	22	31
	BWI	26	27				

Table A6: List of FOMC meeting dates and times

This table reports dates of FOMC meetings over February 1995 to December 2008. The dates in bold refer to unscheduled meetings. The time of the FOMC announcements, reported in square brackets, is obtained from Gorodnichenko and Weber (2016).

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1995	1-Feb-95	28-Mar-95	23-May-95	6-Jul-95	22-Aug-95	26-Sep-95	15-Nov-95	19-Dec-95		
	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]		
1996	31-Jan-96	26-Mar-96	21-May-96	3-Jul-96	20-Aug-96	24-Sep-96	13-Nov-96	17-Dec-96		
	[14:15]	[11:39]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]		
1997	5-Feb-97	25-Mar-97	20-May-97	2-Jul-97	19-Aug-97	30-Sep-97	12-Nov-97	16-Dec-97		
	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]		
1998	4-Feb-98	31-Mar-98	19-May-98	1-Jul-98	18-Aug-98	29-Sep-98	**15-Oct-98**	17-Nov-98	22-Dec-98	
	[14:12]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[15:15]	[14:15]	[14:15]	
1999	3-Feb-99	30-Mar-99	18-May-99	30-Jun-99	24-Aug-99	5-Oct-99	16-Nov-99	21-Dec-99		
	[14:12]	[14:12]	[14:11]	[14:15]	[14:15]	[14:12]	[14:15]	[14:15]		
2000	2-Feb-00	21-Mar-00	16-May-00	28-Jun-00	22-Aug-00	3-Oct-00	15-Nov-00	19-Dec-00		
	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:12]	[14:12]	[14:15]		
2001	**3-Jan-01**	31-Jan-01	20-Mar-01	**18-Apr-01**	15-May-01	27-Jun-01	21-Aug-01	2-Oct-01	6-Nov-01	11-Dec-01
	[13:13]	[14:15]	[14:15]	[10:54]	[14:15]	[14:12]	[14:15]	[14:15]	[14:20]	[14:15]
2002	30-Jan-02	19-Mar-02	7-May-02	26-Jun-02	13-Aug-02	24-Sep-02	6-Nov-02	10-Dec-02		
	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]		
2003	29-Jan-03	18-Mar-03	6-May-03	25-Jun-03	12-Aug-03	16-Sep-03	28-Oct-03	9-Dec-03		
	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]		
2004	28-Jan-04	16-Mar-04	4-May-04	30-Jun-04	10-Aug-04	21-Sep-04	10-Nov-04	14-Dec-04		
	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]	[14:15]		
2005	2-Feb-05	22-Mar-05	3-May-05	30-Jun-05	9-Aug-05	20-Sep-05	1-Nov-05	13-Dec-05		
	[14:17]	[14:17]	[14:16]	[14:15]	[14:17]	[14:17]	[14:18]	[14:13]		
2006	31-Jan-06	28-Mar-06	10-May-06	29-Jun-06	8-Aug-06	20-Sep-06	25-Oct-06	12-Dec-06		
	[14:14]	[14:17]	[14:17]	[14:16]	[14:14]	[14:14]	[14:13]	[14:14]		
2007	31-Jan-07	21-Mar-07	9-May-07	28-Jun-07	7-Aug-07	**10-Aug-07**	18-Sep-07	31-Oct-07	11-Dec-07	
	[14:14]	[14:15]	[14:15]	[14:14]	[14:14]	[9:15]	[14:15]	[14:15]	[14:16]	
2008	30-Jan-08	18-Mar-08	30-Apr-08	25-Jun-08	5-Aug-08	16-Sep-08	**8-Oct-08**	29-Oct-08	16-Dec-08	
	[14:14]	[14:14]	[14:15]	[14:09]	[14:13]	[14:14]	[7:00]	[14:17]	[14:21]	

A Robustness checks [Add discussions about HD in all appendix tables]

A.1 Alternative econometric specifications

We first consider an alternative econometric specification for the baseline model which uses "raw" data on sentiment measures, as opposed to dummy variables capturing two sentiment states. Moreover, it accounts for the possibility that returns at the event frequency are affected by past (start of the year) sentiment:

$$R_t = \beta_0 + \beta_1 S_{t-1} + \beta_2 \Delta i_t^u + \beta_3 S_{t-1} \Delta i_t^u + \varepsilon_t \tag{A1}$$

where S_{t-1} denotes the sentiment value at the end (December) of the previous year and all other variables are as previously defined.

Panel A in Table A7 reports estimates of Equation A1. The coefficient of interest, β_3, indicates that when lagged sentiment is higher, the stock market reaction to unexpected FFR changes is stronger. Hence, the evidence is consistent with our baseline findings. Lagged sentiment on its own, as captured by β_1, is typically statistically insignificant. Moreover, we consider a second specification which replaces S_{t-1} with S_t^H. The results in Panel B of Table A7 are consistent with those in Panel A since β_3 remains highly significant.

A.2 Excluding employment data releases

In the early 1990s, the Fed's decisions to cut rates may have reflected an endogenous reaction to labour market conditions. Between June 1989 and September 1992 (the date of the last FFR cut associated with employment news), nearly half of the FOMC meetings coincided with the release of a worse-than-expected employment report (Bernanke and Kuttner (2005)). In order to account for the possibility that unexpected FFR changes on FOMC meetings that coincide with employment data releases may in fact reflect endogenous responses to the release of this information, we remove 9 such FOMC meetings

from the sample (see Table A2 for a list of the meetings). Table A8 shows that the effect of FFR surprises is conditional on the state of investor sentiment, materializing only following periods of high sentiment.

A.3 Sample starting in February 1994

We consider an alternative starting point for the sample period in the estimation of the effect of target rate surprises. We use February 1994, that is, the time when the Fed started to announce its policy actions, representing a shift that enhanced transparency in monetary policy making. Table A9 reports the results. Our findings are similar to those from using the sample that begins in June 1989.

A.4 Alternative sentiment measure

Huang et al. (2015) use the partial least squares (PLS) method to develop a new sentiment index. They extend the standard market-based approach (Baker and Wurgler, 2006; Baker and Wurgler, 2007) so that the investor sentiment measure is aligned with the purpose of predicting future stock returns. We construct level- and changes-based dummy variables based on the PLS index of Huang et al. (2015) using the same approach as in section 2.2. We then repeat the analyses for the impact of FFR shocks and path surprises and present the results in Table A10 Panels A and B, respectively. Overall, the results are similar to those from using the other sentiment measures. The market response to FFR shocks before the ZLB materializes only following periods of high sentiment. Moreover, the impact of path surprises at the ZLB is statistically significant only during periods of decreasing sentiment.

A.5 Accounting for outliers

We employ the M-estimation, using the procedure of Huber (1964), which is robust to the presence of outliers. Tables A11 reports the results for the market-wide response to FFR shocks and path surprises, respectively. In line with the findings from OLS estimation,

stock market returns react to FFR shocks (path surprises) only following periods of high sentiment (during periods of decreasing sentiment).

A.6 Alternative changes-based classification

For our benchmark analysis, we define periods of decreasing (increasing) sentiment as those years when the value of the sentiment measure in December is lower (higher) than that in the December of the previous year. We use an alternative yearly classification scheme in which a year is defined as of decreasing (increasing) sentiment if, throughout it, the average monthly change of the orthogonalized sentiment proxy is negative (positive). For the CSI and CCI measures, we first orthogonalize the monthly changes of the original indexes to the six macroeconomic variables used by Baker and Wurgler (2006), and then calculate the average value of the monthly residuals throughout each year. In the case of the BWI, we start by orthogonalizing the monthly changes of each of its five constituents, and then obtain the first principal component of the residuals, and finally calculate the average value of the principal component throughout each year. Table A12 presents the findings for the impact of path surprises on the stock market. Results from the alternative changes-based dummy are overall in line with the findings from using December-to-December changes. Stock market returns respond to monetary policy shocks during periods of decreasing sentiment only.

A.7 Additional variables for orthogonalization

In order to ensure that the residuals from the orthogonalizing regressions capture sentiment that is unrelated to economic fundamentals, rather than the effect of omitted variables, we use an extended set of macro-related factors for the orthogonalization. This helps us to further assess the potential of a risk-based explanation for our findings. To this end, we follow Stambaugh, Yu, and Yuan (2012) and expand the set of macro-related variables used by Baker and Wurgler (2006) by including the default premium (BAA minus AAA corporate bond yield spread), the term premium (10-year minus 1-year Treasury bond yield spread), the real interest rate (1-month Treasury bill rate minus the monthly

Consumer Price Index inflation rate), the inflation rate, and the consumption-wealth ratio (cay) defined in Lettau and Ludvigson (2001).[1] Table A13 reports the results for the stock market response to FFR shocks and path surprises, respectively. The results are quantitatively similar to those we reported earlier, and indicate that our findings are robust to the use of a more extensive set of macro-variables for the orthogonalization of sentiment.

A.8 Longer estimation window for CAARs

We repeat the analyses for the effect of LSAPs and liquidity facilities announcements using a 90-day estimation window, instead of the 20-day window used earlier. Table A14 reports the response of stock market returns to the unconventional monetary policy announcements. Overall, the results are similar to those from using the 20-day estimation window, albeit with slightly lower CAARs.

[1] cay is obtained from Sydney Ludvigson's website, http://www.econ.nyu.edu/user/ludvigsons/.

Table A7: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - alternative econometric specifications

Panel A of this table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1 S_{t-1}+\beta_2\Delta i_t^u+\beta_3 S_{t-1}\Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_{t-1} denotes the raw sentiment value at the end (December) of the previous year. Panel B of this table replaces S_{t-1} with S_t^H. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel C we replace S_{t-1} in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	β_3	$Adj.R^2$
Panel A: S_{t-1}						
CSI	181	0.25***	0.14*	-1.68	−3.30***	0.19
		(0.09)	(0.07)	(1.23)	(0.61)	
CCI	181	0.20**	0.10	−3.93***	−4.47***	0.15
		(0.09)	(1.13)	(1.24)	(1.48)	
BWI	181	0.20**	0.08	−4.21***	−3.74***	0.14
		(0.10)	(0.12)	(1.31)	(1.31)	
Panel B: S_t^H						
CSI	181	-0.09	0.40**	-1.29	−5.58**	0.16
		(0.16)	(0.19)	(1.22)	(2.54)	
CCI	181	0.10	0.17	-0.80	−6.34**	0.14
		(0.12)	(1.18)	(1.03)	(2.58)	
BWI	181	0.16	0.12	-0.63	−6.06**	0.13
		(0.11)	(0.17)	(1.12)	(2.50)	
Panel C: S_t^{HD}						
CSI	181	0.13	0.17	-0.46	−7.49***	0.17
		(0.10)	(0.19)	(1.00)	(2.57)	
CCI	181	0.15	0.14	-0.46	−7.53***	0.17
		(0.10)	(0.19)	(1.00)	(2.58)	

Table A8: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - excluding employment releases

This table presents OLS estimates with heteroscedasticity-consistent standard errors, excluding meetings that coincide with employment report releases, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)\Delta i_t^u+\beta_2 S_t^H \Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, excluding meetings associated with the release of employment reports, as well as the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
Panel A: S_t^H					
CSI	172	0.22^{**}	-1.52	-7.07^{***}	0.14
		(0.09)	(1.34)	(2.22)	
CCI	172	0.21^{**}	-1.67	-7.24^{***}	0.14
		(0.09)	(1.25)	(2.31)	
BWI	172	0.23^{**}	-1.47	-6.80^{***}	0.14
		(0.09)	(1.41)	(2.19)	
Panel B: S_t^{HD}					
CSI	172	0.22^{**}	-1.06	-8.13^{***}	0.17
		(0.09)	(1.25)	(2.29)	
CCI	172	0.22^{**}	-1.13	-8.09^{***}	0.17
		(0.09)	(1.25)	(2.30)	

Table A9: Pre-ZLB response of stock market returns to FFR shocks conditional upon the state of investor sentiment - sample commences in February 1994

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^u + \beta_2 S_t^H \Delta i_t^u + \varepsilon_t$, where R_t and Δi_t^u denote CRSP value weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The pre-zero lower bound (ZLB) sample period includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
Panel A: S_t^H					
CSI	126	0.27**	-1.67	−7.33***	0.16
		(0.11)	(2.35)	(2.39)	
CCI	126	0.26**	-1.99	−7.51***	0.16
		(0.12)	(2.08)	(2.50)	
BWI	126	0.27**	1.66	−6.72***	0.15
		(0.11)	(5.51)	(2.22)	
Panel B: S_t^{HD}					
CSI	126	0.27**	-0.47	−8.62***	0.19
		(0.11)	(1.83)	(2.47)	
CCI	126	0.27**	-0.59	−8.55***	0.19
		(0.11)	(1.83)	(2.47)	

Table A10: Response of stock market returns to monetary policy shocks conditional upon the state of investor sentiment - sentiment regimes defined by PLS sentiment index

Panel A and B of this table present OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)\Delta i_t^u+\beta_2 S_t^H \Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. The pre-zero lower bound (ZLB) sample period used in Panel A and B includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Panel C presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors, over FOMC meeting days of the following model: $R_t=\beta_0+\beta_1(1-S_t^D)path_t+\beta_2 S_t^D path_t+\varepsilon_t$, where $path_t$ denotes path surprises. S_t^D is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. The zero lower bound (ZLB) sample period in Panel C includes scheduled FOMC meetings over January 2009 - October 2014. PLS denotes the sentiment index developed by Huang et al. (2015). Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
Panel A: FFR shocks - S_t^H					
PLS	181	0.21**	-0.50	−7.40***	0.15
		(0.09)	(1.50)	(2.28)	
Panel B: FFR shocks - S_t^{HD}					
PLS	181	0.21**	-0.60	−7.37***	0.14
		(0.09)	(1.49)	(2.30)	
Panel C: Path surprises - S_t^D					
PLS	47	0.31	-4.73	−2.40**	0.04
		(0.20)	(5.89)	(1.18)	

Table A11: Response of stock market returns to monetary policy shocks conditional upon the state of investor sentiment - robust estimates against outliers

Panel A and B of this table present M weighted least squares estimates using the procedure of Huber (1964), which is robust to the presence of outliers, over FOMC announcement days, of the following model: $R_t = \beta_0 + \beta_1(1 - S_t^H)\Delta i_t^u + \beta_2 S_t^H \Delta i_t^u + \varepsilon_t$, where R_t and Δi_t^u denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. The pre-zero lower bound (ZLB) sample period used in Panel A and B includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008. Panel C presents M estimates over FOMC meeting days of the following model: $R_t = \beta_0 + \beta_1(1 - S_t^D)path_t + \beta_2 S_t^D path_t + \varepsilon_t$, where $path_t$ denotes path surprises. S_t^D is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. The zero lower bound (ZLB) sample period in Panel C includes scheduled FOMC meetings over January 2009 - October 2014. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
Panel A: FFR shocks - S_t^H					
CSI	183	0.20^{***}	-0.35	-2.70^{***}	0.01
		(0.08)	(1.12)	(0.86)	
CCI	183	0.20^{***}	-0.49	-2.69^{***}	0.01
		(0.08)	(1.08)	(0.86)	
BWI	183	0.21^{***}	-0.61	-1.69^{**}	0.01
		(0.08)	(1.14)	(0.84)	
Panel B: FFR shocks - S_t^{HD}					
CSI	183	0.20^{***}	-0.28	-4.00^{***}	0.02
		(0.08)	(1.05)	(0.87)	
CCI	183	0.20^{**}	-0.33	-3.82^{***}	0.01
		(0.08)	(1.07)	(0.88)	
Panel C: Path surprises - S_t^D					
CSI	47	0.18	0.56	-3.73^{**}	0.16
		(0.17)	(1.77)	(1.50)	

Table A12: ZLB response of stock market returns to path surprises conditional upon the state of investor sentiment - alternative changes-based sentiment dummy

This table presents OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t = \beta_0 + \beta_1(1 - S_t^D)path_t + \beta_2 S_t^D path_t + \varepsilon_t$, where R_t and $path_t$ denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and path surprises, respectively. S_t^D is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if, throughout it, the average monthly change of the sentiment proxy is negative (positive). CSI and BWI denote the University of Michigan's Consumer Sentiment index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. The zero lower bound (ZLB) sample period includes scheduled FOMC meetings over January 2009 - October 2014. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
CSI	47	0.39**	-1.19	−12.56*	0.20
		(0.17)	(1.00)	(6.89)	
BWI	47	0.36**	-1.18	−11.30*	0.19
		(0.17)	(1.03)	(5.6)	

Table A13: Response of stock market returns to monetary policy shocks conditional upon the state of investor sentiment - alternative orthogonalization to economic variation

Panel A and B of this table present OLS estimates with heteroscedasticity-consistent standard errors, over FOMC announcement days, of the following model: $R_t=\beta_0+\beta_1(1-S_t^H)\Delta i_t^u+\beta_2 S_t^H \Delta i_t^u+\varepsilon_t$, where R_t and Δi_t^u denote CRSP value weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. S_t^H is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a year that starts with high (low) sentiment level. A year is defined as starting with high (low) sentiment if the sentiment proxy at the end (December) of the previous year is above (below) the full sample mean value. In Panel B we replace S_t^H in the above equation with S_t^{HD}, a dummy variable that is equal to 1 if the FOMC meeting occurred during a year when sentiment starts at high level but then declines, and 0 otherwise. A year is defined as of high at the start but then decreasing sentiment if the sentiment proxy at the end (December) of the previous year exceeds the full sample mean value and the sentiment proxy at the end of that year is lower than at the end of the previous year. The pre-zero lower bound (ZLB) sample period used in Panel A and B includes scheduled and unscheduled FOMC meetings over June 1989 - December 2008, with the exception of the 17 September 2001 and 22 January 2008 unscheduled meetings. Panel C presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors, over FOMC meeting days of the following model: $R_t=\beta_0+\beta_1(1-S_t^D)path_t+\beta_2 S_t^D path_t+\varepsilon_t$, where $path_t$ denotes path surprises. S_t^D is a dummy variable that is equal to 1 (0) if the FOMC meeting occurred during a decreasing (increasing) sentiment year. A year is defined as of decreasing (increasing) sentiment if the sentiment proxy at the end (December) of that year is lower (higher) than at the end of the previous year. The zero lower bound (ZLB) sample period in Panel C includes scheduled FOMC meetings over January 2009 - October 2014. The additional macro-related variables used for the orthogonalization of the sentiment indices include: the default premium, the term premium, the real interest rate, the inflation rate, and the consumption-wealth ratio. CSI, CCI and BWI denote the University of Michigan's Consumer Sentiment index, the U.S. Consumer Confidence index and Baker and Wurgler's (2006, 2007) sentiment index, respectively. Standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Obs	β_0	β_1	β_2	$Adj.R^2$
Panel A: FFR shocks - S_t^H					
CSI	181	0.21^{**}	0.11	-9.36^{***}	0.21
		(0.09)	(1.31)	(1.47)	
CCI	181	0.21^{**}	-0.42	-7.64^{***}	0.15
		(0.09)	(0.94)	(2.28)	
BWI	181	0.24^{***}	-0.36	-7.12^{***}	0.14
		(0.09)	(1.00)	(2.24)	
Panel B: FFR shocks - S_t^{HD}					
CSI	181	0.21^{**}	-3.41^{*}	-5.73^{**}	0.07
		(0.09)	(1.75)	(2.61)	
CCI	181	0.21^{**}	-1.47	-7.35^{***}	0.12
		(0.09)	(1.26)	(2.64)	
Panel C: Path surprises - S_t^D					
CSI	47	0.23	0.63	-4.63^{***}	0.12
		(0.18)	(0.69)	(1.55)	
CCI	47	0.25	0.49	-4.59^{***}	0.12
		(0.17)	(0.72)	(1.56)	

Table A14: Response of stock market returns to LSAPs and liquidity facilities announcements conditional upon the state of investor sentiment - longer estimation window

This table presents the CRSP value-weighted cumulative average abnormal returns (CAARs (%)) using alternative event windows across periods of decreasing sentiment (Panel A) and increasing sentiment (Panel B). Returns are in excess of the 1-month Treasury bill rate. Abnormal returns are calculated using the constant mean model and a 90-day estimation period that ends prior to the event window. We consider announcements of expansionary nature by the Fed over the period December 2007 - October 2013 that reflect the initiation or continuation of Large Scale Asset Purchases (LSAPs) and liquidity facilities programmes. There are 46 announcements related to liquidity facilities (LIQ_{all}), including 13 announcements about central bank liquidity swaps (CB swaps), 13 announcements about the term auction facility (TAF) and 21 announcements about other liquidity facilities (Other). 22 LSAPs-related announcements are also considered. A year is defined as of decreasing (increasing) sentiment if the University of Michigan's Consumer Sentiment index at the end (December) of that year is lower (higher) than at the end of the previous year. The statistical significance of CAARs is evaluated using the Boehmer, Masumeci, and Poulsen (1991) test statistic that accounts for event-induced increase in returns volatility. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Event window	CB swaps	TAF	Other	LIQ_{all}	LSAPs	LIQ_{all}+LSAPs
Panel A: Decreasing sentiment						
(-1, 3)	2.81	-2.02	-0.66	-0.23	2.37	-0.02
(-1, 1)	2.90**	-0.80	0.15	0.50	2.40	0.49
(0, 0)	1.44**	-0.44	-0.04	0.14	0.25	0.13
Panel B: Increasing sentiment						
(-1, 3)	0.76			0.76	-0.15	0.03
(-1, 1)	0.21			0.21	-0.13	-0.06
(0, 0)	0.96			0.96	0.06	0.24

References

Baker, Malcolm, and Jeffrey Wurgler, 2006, Investor sentiment and the cross-section of stock returns, *Journal of Finance* 61, 1645–1680.

Baker, Malcolm, and Jeffrey Wurgler, 2007, Investor sentiment in the stock market, *Journal of Economic Perspectives* 21, 129–152.

Bernanke, Ben S, 2015, *The Courage to Act: A Memoir of a Crisis and its Aftermath*, first edition (W. W. Norton & Company).

Bernanke, Ben S, and Kenneth N Kuttner, 2005, What explains the stock market's reaction to Federal Reserve policy?, *Journal of Finance* 60, 1221–1257.

Gorodnichenko, Yuriy, and Michael Weber, 2016, Are sticky prices costly? evidence from the stock market, *American Economic Review* 106, 165–99.

Greenspan, Alan, 2008, *The age of turbulence: Adventures in a new world* (Penguin).

Huang, Dashan, Fuwei Jiang, Jun Tu, and Guofu Zhou, 2015, Investor sentiment aligned: A powerful predictor of stock returns, *Review of Financial Studies* 28, 791–837.

Huber, Peter J, 1964, Robust estimation of a location parameter, *The Annals of Mathematical Statistics* 35, 73–101.

Lettau, Martin, and Sydney Ludvigson, 2001, Consumption, aggregate wealth, and expected stock returns, *Journal of Finance* 56, 815–849.

Stambaugh, Robert F, Jianfeng Yu, and Yu Yuan, 2012, The short of it: Investor sentiment and anomalies, *Journal of Financial Economics* 104, 288–302.