Investor Sentiment and Stock Market Price Reactions to Monetary Policy News

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

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Abstract

In this paper, we show that the state of investor sentiment strongly affects the response of stock prices to news about the Fed’s conventional and non-conventional monetary policies. We find that the stock price reaction to monetary policy news is significant only following periods of high sentiment and during periods of decreasing sentiment. Our evidence posts a challenge to the rational asset pricing viewpoint.

Keywords: Investor Sentiment, Monetary Policy, Stock Returns

JEL classification: G11, G12, G14, E44, E52.

*Adam Smith Business School, Accounting and Finance subject area, University of Glasgow, Glasgow, G12 8QQ, UK, h.guo.1@research.gla.ac.uk
†Adam Smith Business School, Accounting and Finance subject area, University of Glasgow, Glasgow, G12 8QQ, UK, chi-hsiou.hung@glasgow.ac.uk
‡Essex Business School, Finance subject group, University of Essex, Colchester, CO4 3SQ, UK, a.kontonikas@essex.ac.uk

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1 Introduction

Classical theory in financial economics does not consider investor sentiment for analyzing the impacts of monetary policy decisions on stock prices. Several studies document a significant stock price response to monetary policy shifts (Thorbecke (1997); Ehrmann and Fratzscher (2004); Bernanke and Kuttner (2005); Kontonikas and Kostakis (2013); Maio (2014)), and argue that shifts in monetary policy affect stock prices through changes in the discount rate and through changes in the expected future cash flows (Patelis (1997)).

In this paper, we present evidence that the state of investor sentiment may affect the way by which stock prices react to monetary policy news, and show that there exists a behavioral channel in the monetary policy transmission mechanism to the stock market. Our focus is on the stock price response at the broad market level to monetary policy decisions made by the Federal Open Market Committee (FOMC). We start with the theory and evidence that investor sentiment affects stock prices (Lee, Shleifer, and Thaler (1991); Kumar and Lee (2006); Baker and Wurgler (2006); Stambaugh, Yu, and Yuan (2012); Chung, Hung, and Yeh (2012); Shen, Yu, and Zhao (2017)).

Because a monetary policy shock makes investors become either more optimistic or pessimistic, which in turn stimulates trading, we predict that sentiment-based demand affects the difficulty of arbitrage, that is, the binding effect of arbitrage constraints becomes intensified when broad waves of sentiment grow stronger in times when sentiment started high. Concretely, we argue that it is more difficult to carry out price-correcting arbitrage in periods following high sentiment than in periods following low sentiment. We predict that such relatively higher arbitrage difficulty allows a stronger price increase in response to an expansionary monetary policy shock in periods following high sentiment than in periods following low sentiment. Importantly, our focus is on the variation in the effect of arbitrage constraints over time, instead of its variation across stocks as analyzed by, for example, Baker and Wurgler (2006), which emphasizes that the risk and costs of arbitrage for certain stocks are particularly high.

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1 Using a returns 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.
The extant literature shows that, in the presence of limited arbitrage, the build-up of optimism when sentiment is on the rise leads to an extended period of market overvaluation, with stock prices departing from the rationally discounted value of expected cash flows (De Long et al. (1990); Lee, Shleifer, and Thaler (1991)). Essentially, investors assign excessively optimistic valuations to future cash flows, either by overestimating the size of the cash flows or by underestimating the risk (Mian and Sankaraguruswamy (2012); Kaplanski et al. (2015)). Studies in psychology also find that sentiment can affect the evaluation of potential outcomes as well as risk-assessment (Johnson and Tversky (1983); Loewenstein et al. (2001)). When fundamentals are revealed, the mispricing is subsequently corrected, resulting in lower future stock returns. In contrast, there is no substantial underpricing when sentiment is low (Yu and Yuan (2011); and Chung, Hung, and Yeh (2012)) and hence, no correction for mispricing during periods following low sentiment. We posit that the stock market impact of monetary policy actions is concentrated during periods when the mispricing is corrected.

We adopt two approaches to classify the state of investor sentiment. The first classification approach is based on the level of sentiment. Following Baker and Wurgler (2006), we define a year as starting with high sentiment if the sentiment measure at the end of the previous year exceeds the full sample mean value. The second considers changes in sentiment and classifies a year as of decreasing sentiment if the sentiment measure at the end of that year is lower than that at the end of the previous year. Since investor sentiment exhibits a mean-reverting property (see, Yu and Yuan (2011) and Chung, Hung, and Yeh (2012)), both classification approaches help to capture the price response of stocks to monetary policy news during the correction phase that follows the period of overvaluation. We employ three monthly measures of investor sentiment: the University of Michigan Consumer Sentiment Index, the U.S. Consumer Confidence Index and the Sentiment Index constructed by Baker and Wurgler (2006), with each of which being orthogonalized to a set of macroeconomic variables, thereby removing variation due to economic components.

Using an event study regression methodology over the sample period 1989-2014, we find
that the state of investor sentiment affects stock price responses to monetary policy shocks, supporting our hypothesis. Our first approach of identifying monetary policy shocks centers on conventional policy, and measures unexpected changes in the Federal funds rate (FFR). We approximate market-based expectations via FFR futures contracts (Kuttner (2001)). Our evidence strongly rejects the null hypothesis of equal stock market reactions across different sentiment states, and shows that, following high sentiment periods, the stock market responds positively to monetary easing shocks. Specifically, in response to an unexpected FFR cut of 25 basis points, the excess stock market return increases by about 2% in a day. In contrast, when sentiment is low at the start of the year, the impact of monetary policy news on the excess stock market return is insignificant. We also analyze the joint effect of the level and changes of sentiment, and find that the impact of policy shifts is stronger during years that sentiment starts at high level and subsequently declines. Moreover, we show that the stock market response to monetary policy news depends on the type of news that investors are faced with, as classified by the sign of the FFR shock. The strong response that we identify, following periods of high sentiment, is highly asymmetric, and is driven by expansionary policy surprises.

Our second approach of identifying monetary policy shocks focuses on non-conventional monetary policies, which have played a prominent role since the recent financial crisis. The FFR reached the zero lower bound (ZLB) on December 2008 and remained low until the end of our sample period. During these years, the Fed’s approach to monetary policy is characterized by increasing reliance on forward guidance, whereby the Fed attempts to influence the path of future short-term rates through various communication channels. We measure path surprises using the methodology of Gürkaynak, Sack, and Swanson (2005), and find that, consistent with our findings from using FFR shocks, during periods of decreasing sentiment stock prices are influenced by path surprises. Specifically, an unexpected decline of 25 basis points in the interest rate path during the ZLB period is associated with a 1-day excess stock market return of about 1%.

The Fed also implemented major changes in the size and composition of its balance sheet through Large-Scale Asset Purchases (LSAPs) and the provision of liquidity fa-
ilities. We examine the effects of these non-conventional policy interventions using an event study framework where abnormal stock returns are estimated in short windows surrounding the policy announcements. We consider announcements of expansionary nature, related to the initiation or continuation of LSAPs and liquidity facilities programmes, and we adopt a constant mean return model following MacKinlay (1997), where the mean is calculated using a 20-day estimation period. We find that stock prices benefit from the announcement of central bank liquidity swaps, as indicated by positive and significant cumulative average abnormal returns. Nevertheless, the effect is conditional on investor sentiment regimes, materializing only during periods that are characterised by negative changes in sentiment.

We conduct a host of robustness checks and, overall, our findings remain strong and consistent. First, we remove FOMC meetings that coincide with releases of employment data to account for the possibility that FFR changes on such meetings were an endogenous reaction to economic developments. Second, we use February 1994 as an alternative sample starting point to reflect the fact that only then the Fed started to announce target FFR changes. Third, we use an alternative sentiment measure developed by Huang et al. (2015). Fourth, we use MM weighted least squares estimation developed by Yohai (1987), which is robust to the presence of outliers, to replace Ordinary Least Squares (OLS). Fifth, we use a different approach to identify changes-based sentiment regimes. Sixth, we use an extended set of macro-related factors for the orthogonalization of sentiment, which ensures that our results are not driven by omitted variables. Finally, we use a longer estimation window when conducting the event study for the effect of non-conventional monetary policy announcements.

A study that is most closely related to ours at a conceptual level is that of Mian and Sankaraguruswamy (2012), who examine whether stock price changes to firm-specific earnings surprises is affected by sentiment, and conclude that behavioral biases affect how accounting information is impounded into stock prices. Our findings also question the rational asset pricing viewpoint. Importantly, we focus on market-wide news stemming from shifts in monetary policy, rather than firm-specific information. Furthermore, while Mian
and Sankaraguruswamy (2012) simply interact a lagged measure of monthly sentiment with their news variable, we identify regimes based on the level of sentiment relative to its mean and also on changes in sentiment, and use these to estimate the impact of news across different sentiment regimes.

This study finds that the effect of monetary policy surprises is conditional on the state of investor sentiment. Sentiment-driven mispricing is key in our analysis, but has not been considered in the extant literature on the relationship between monetary policy and the pricing of stocks. Previous studies on state-dependence in the response of stock prices to monetary policy shifts focus on macroeconomic factors, rather than investor sentiment, and find that the stock price reaction is stronger during recessions and tight credit market conditions (Perez-Quiros and Timmermann (2000); Basistha and Kurov (2008)). Garcia (2013) argues that investors’ reactions to news may differ across the business cycle, since they tend to be more sensitive to news when they go through “hard times”. In this study, however, we do not use recessions to proxy for “hard times”. Instead, we employ measures of sentiment that are orthogonal to macroeconomic conditions. Our evidence of sentiment-dependence is crucial for distinguishing between behavioural and economic fundamentals-based explanations for the asymmetric stock price response to monetary policy news.

The rest of the paper proceeds as follows. Section 2 develops our hypotheses. Section 3 describes the data and variables that we employ in the empirical analysis. Section 4 presents evidence related to the role of investor sentiment in the transmission of monetary policy shifts to the stock market. Section 5 presents the results from various robustness checks. Finally, Section 6 concludes.

2 Sentiment and the stock price reaction to monetary policy news

Studies on monetary policy have documented the crucial role of policy shifts on stock prices, both at the market and portfolio levels. Several papers find that expansionary
surprises are associated with higher stock prices using high frequency event studies or low frequency VAR models (Thorbecke (1997); Ehrmann and Fratzscher (2004); Bernanke and Kuttner (2005); Chen (2007); Wright (2012); Swanson (2015)). The positive stock price reaction to news about monetary policy easing is consistent with rational asset pricing, reflecting lower discount rates and higher expected future cash flows. In addition to arguments based on the dividend discount model, macroeconomic-based models highlight the importance of a risk factor related to the stance of monetary policy for the pricing of stocks (Bakshi and Chen (1996); Balvers and Huang (2009); Lioui and Maio (2014)).

According to the rational viewpoint, the stock price response to monetary policy shocks should not be significantly different following periods of high or low sentiment. Hence, for example, monetary policy easing should be boosting stock prices in a similar manner across different states of investor sentiment.

In this paper, we argue that the effect of monetary policy news on stock prices differs across different states of investor sentiment. We hypothesize that the positive stock price response to expansionary monetary policy shocks is stronger following periods of high sentiment, that is, the impact of monetary policy on the stock market is concentrated during the correction phase that comes after sentiment-driven overvaluation. This implies that a stronger price response following periods of high sentiment is consistent with a common market-wide mispricing. Brown and Cliff (2005) provide evidence of sentiment-driven mispricing at the level of broad market indexes, and Baker and Wurgler (2006), Stambaugh et al. (2012), and Stambaugh and Yuan (2016) discuss the notion of a common sentiment-related component of mispricing. At the stock market level, many studies also provide strong evidence of sentiment-driven mispricing (Baker and Wurgler (2007); Baker, Wurgler, and Yuan (2012); Ben-Rephael, Kandel, and Wohl (2012); Huang et al. (2015)).

A substantial body of literature in finance establishes that investor sentiment drives mispricing in the stock market. Yu and Yuan (2011) point out that the stock market becomes less rational during high sentiment periods, as a result of high participation of noise traders, and document that the relationship between the expected return and conditional volatility of the stock market is nearly flat during such periods. Abreu and Brunnermeier (2003) argue that noise traders are subject to animal spirits, fads and fashions, overconfidence and other psychological biases. Hirschleifer (2001), among others, documents and analyzes these effects. Chung, Hung, and Yeh (2012) emphasize that sentiment-driven overpricing is more prevalent than underpricing due to the limits of arbitrage and short-shares constraints. In the model of De Long et al. (1990), the unpredictability of noise traders’ beliefs deters rational arbitrageurs from aggressively betting against them. Arbitrageurs face the risk of investors’ optimism becoming more extreme...
The key premise of this paper is that the sensitivity of stock prices to monetary policy news is conditional on the state of investor sentiment. Our hypothesis is based on the argument that the difficulty of arbitrage varies over time, in which the limits to arbitrage become intensified when broad waves of sentiment grow stronger. We argue that the difficulty of carrying out price-correcting arbitrage in periods following high sentiment is higher than in periods following low sentiment, and that such relatively higher arbitrage difficulty allows a stronger price increase in the face of an expansionary monetary policy shock than in periods following low sentiment.

In periods following high sentiment, noise traders’ participation in the stock market is high, hence high propensity to speculate, which makes arbitrage particularly difficult. As analyzed in De Long et al. (1990), this noise-trader risk deters arbitrageurs from taking a short position when expansionary monetary policy shocks stimulate a price surge because sentimental investors may push prices further away from fundamentals. Taking a contrarian arbitrage also risks investors’ capital withdrawals from arbitrageurs just when mispricing is greatest (Shleifer and Vishny (1997)). Further, expansionary monetary policy shocks raise the prospect of firms’ expected future cash flows and decrease the discount rates, which increase the value of firm fundamentals. Importantly, although the valuation of firm fundamentals is expected to increase, the exact magnitude of the valuation increase and the timing to realize the economic impact of an expansionary monetary policy shock on firm fundamentals remain uncertain and subject to speculation. This uncertainty is in the spirit of fundamental risk discussed in Campbell and Kyle (1993). As discussed in Baker and Wurgler (2007), uncertainty makes psychological biases, such as overconfidence (Daniel, Hirshleifer, and Subrahmanyam (1998)), representativeness, and conservatism (Barberis, Shleifer, and Vishny (1998)), more profound and differences of opinion (Miller (1977)) large, even when investors share the same information. As a
result, the willingness of arbitrageurs to aggressively bet against noise traders is lower.

Indeed, our evidence shows that measures of liquidity and volatility at the market level, which we proxy for the active participation of sentiment investors, are high relative to the sample means in periods following high sentiment, while these measures are lower than the sample means in periods following low sentiment. According to Baker and Stein (2004), high liquidity indicates high participation of irrational investors and hence, overvaluation. For the measures of liquidity, we consider the aggregate levels of trading volume, bid-ask spread, price impact of trade and share turnover (Amihud (2002)).

In contrast, in periods following low sentiment, noise traders’ participation in the stock market is low, and it is the view of rational investors that sustain the price level (Stambaugh and Yuan (2016)). Rational investors make unbiased adjustments of asset valuation in response to expansionary monetary policy shocks. Therefore, the likelihood of an overpricing is relatively low and so does the extent of mispricing. Even if sentiment investors undervalue stocks in periods following low sentiment, the force of long positions taken by rational investors would eliminate underpricing. Thus, we argue that, in periods following low sentiment, because the aggregation of heterogeneous valuation adjustments of investors that forms the market price, the market price response is relatively moderate when a positive monetary policy shock arrives, given a market environment where there is little chance of underpricing and also low probability of a price overshooting.

As Kurov (2010) points out, investors believe in the the Fed’s ability to put a floor to falling stock prices, via monetary easing, in periods of market stress.³ Appealing to psychological studies, Garcia (2013) argues that investors may use different decision-making rules in “good times”, when they are feeling optimistic, and “hard times”, when pessimism prevails, and are more sensitive to news during the latter.⁴ On the other hand, following low sentiment periods, there is little mispricing to be corrected. Hence, investors are less likely to experience “hard times”, and their sensitivity to news about expansionary

³The Fed’s interventions affect discount rates and cash flows expectations, but can also have a direct impact on sentiment (Kurov (2010); Lutz (2015)).

⁴The psychological literature suggests that sentiment affects the way that individuals process information (Tiedens and Linton (2001)). For example, when pessimistic (optimistic), there is greater reliance on systematic (heuristic) processing of information (Mackie and Worth (1989); Bless et al. (1990)).
monetary policy declines.

This behaviour can generate sentiment-dependence in the stock price reaction to monetary policy news. The intuition developed above leads to our hypothesis:

**Hypothesis:** The stock market reaction to monetary policy news is stronger following periods of high sentiment.

3 Data and sample

In our empirical analysis we estimate the response of stock prices to monetary policy shocks conditional on the state of investor sentiment. Our study covers the sample period from June 1989 to October 2014, hence including the pre-crisis period, the financial crisis and its aftermath. The financial crisis of 2007-2009 had a significant impact on the Fed’s approach to monetary policy implementation. The measures of monetary policy that we use capture both the conventional and non-conventional approaches of the Fed’s policy actions. We employ several proxies for investor sentiment that encapsulate different dimensions of sentiment.

3.1 Monetary policy measures

3.1.1 Target rate surprises

Up to the recent financial crisis, the conduct of monetary policy in the U.S. was characterized by targeting the FFR, which is the interest rate on overnight loans of reserves between banks, and by increasing transparency (Bernanke and Blinder (1992); Bernanke and Mihov (1998); Romer and Romer (2004)). Our full sample includes 227 FOMC meetings, 23 of which were unscheduled.\(^5\) In line with Bernanke and Kuttner (2005), we exclude the unscheduled FOMC meeting that occurred in the aftermath of the 11 September 2001 terrorist attack (17 September 2001) from the sample. We also exclude unscheduled meet-

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\(^5\)The dates provided by Kuttner (2003) are used to identify FOMC meetings prior to February 1994, when there were no press releases regarding FOMC decisions and ambiguity existed about the dates of open market operations. In February 1994 the Fed started to announce target FFR changes, a development that enhanced transparency in monetary policy. The corresponding dates are obtained from the Federal Reserve website at [http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm](http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm).
ings that were not accompanied by a FOMC statement or other information.\(^6\) Finally, we remove the most prominent outlier, as identified by the difference in the fits statistic of Welsch and Kuh (1977), that corresponds to the FOMC meeting on 22 January 2008.\(^7\)

Using the methodology proposed by Kuttner (2001), we isolate the unexpected component of changes in the target FFR ($\Delta i^u_t$) on day $t$ in the month when the FOMC meeting takes place:

$$\Delta i^u_t = \frac{D}{D-t}(f^0_{m,t} - f^0_{m,t-1})$$

where $f^0_{m,t}$ is the current-month implied futures rate (100 minus the futures contract price), and $D$ is the number of days in the month.\(^8\)

This proxy for monetary policy shocks has been extensively used in previous studies that analyze the response of stock prices to monetary policy shifts (Bernanke and Kuttner (2005); Kurov (2010); Kontonikas, MacDonald, and Saggu (2013)). The source of the futures data is Bloomberg, while the FFR data is obtained from the Federal Reserve Economic Database (FRED) maintained by the Federal Reserve Bank of St. Louis.

Figure 1 plots actual and unexpected changes in the target FFR on FOMC meeting dates. Typically, large expansionary monetary policy shocks, as reflected in unexpected declines in the FFR, materialize 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%.

During 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%.

\(^6\)A number of such meetings occur in the latter part of the sample, from January 2008 onwards. These meetings are only dated without further information related to the FFR or asset purchases by the Fed.

\(^7\)On that day, the market declined by almost 1%, in spite of a massive FFR cut of 75 basis points, almost all of which was unexpected.

\(^8\)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 ($f^1_{m,t} - f^1_{m,t-1}$) is used to calculate the FFR surprise. Also, when the FOMC meeting occurs on the first day of the month, $f^1_{m-1,D}$ instead of $f^1_{m,t-1}$, is used to measure the surprise.
Since then and until the end of the sample period, there are no further rate changes and the volatility of FFR shocks dies out. Motivated by these developments, when we estimate the impact of FFR shocks on the stock market, we utilize both the full sample period and a pre-crisis sample period from June 1989 to August 2007.\(^9\)

### 3.1.2 Path surprises

In order to alleviate the constraint to monetary stimulus that the ZLB posed, the Fed provides 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)). Generally, forward guidance implies that the central bank attempts to influence the path of future short-term rates by communicating to the public and financial markets. Forward guidance has been intensively used since 2009, but it has long been a part of the Fed’s toolkit, with elements of it traced to FOMC statements of the Greenspan era (Contessi and Li (2013)). It has been closely associated with a shift towards greater transparency in the conduct of monetary policy (Poole and Rasche (2003)).\(^{10}\)

Gürkaynak, Sack, and Swanson (2005) develop a methodology to identify two dimensions of the Fed’s policy: changes in the current FFR target and changes in forward guidance. They show that both target surprises and path surprises are useful to describe monetary policy shocks. Path surprises should capture news conveyed to market participants by the FOMC’s statement about the expected path of policy above and beyond what they learn for the FFR target level (Wongswan (2009)).

\(^9\)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 (Brunnermeier (2009); Kontonikas, MacDonald, and Saggu (2013)).

\(^{10}\)The outcome of a meeting was announced by the FOMC for the first time in February 1994. The FOMC formally announced in February 1995 that all changes in the stance of monetary policy would be immediately communicated to the public. Since January 2000, the FOMC issues a statement that reports the settings of the target FFR and the balance of risks. At the beginning of forward guidance during the ZLB, the Fed adopted a qualitative tone in its communication with post-FOMC meeting statements including phrases such as the FFR will remain near zero for “an extended period” (FOMC statement of March 18, 2009). This then evolved to date-based guidance, specifying future dates such as “at least through mid-2015” (September 13, 2012). Finally, a threshold-based approach was adopted linking the first rate increase to developments in inflation and unemployment.
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. \(^{11}\)

Our analysis of the impact of path surprises focuses on the ZLB era, in line with Wright (2012) and Swanson (2015), which necessarily narrows the sample to 47 observations for the period January 2009 to October 2014. The average path surprise in Table 1 is equal to -0.01%, with the variable ranging from -0.62% to 0.46%.

### 3.1.3 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 occurs 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.\textsuperscript{12} 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).\textsuperscript{13} 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 market-based expectations to isolate their surprise component, direct measures of expectations regarding the size of LSAPs and liquidity facilities programmes are not available. Hence, we do not attempt to measure “balance sheet shocks”, in line with previous related studies (Gagnon et al. (2011); Ait-Sahalia et al. (2012); Fiordelisi, Galloppo, and Ricci (2014); Ricci (2015)).\textsuperscript{14} Instead, we adopt an event study approach in which we evaluate the behaviour of stock returns in short windows surrounding the LSAPs and liquidity facility announcements.

\textsuperscript{12}The record growth in the monetary base around that period captures the impact of these liquidity facilities (Kontonikas, Nolan, and Zekaite (2015)).

\textsuperscript{13}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.

\textsuperscript{14}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).
3.2 Investor sentiment measures

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). The BWI is a commonly used measure of investor sentiment (Yu and Yuan (2011); Stambaugh, Yu, and Yuan (2012); Shen, Yu, and Zhao (2017)). 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. We also use two consumer confidence indexes, measured outside of the financial markets, as a proxy for investor optimism (see, Lemmon and Portniaguina (2006); Antoniou, Doukas, and Subrahmanyam (2013) and McLean and Zhao (2014)). 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. The CCI is another survey-based measure compiled by the Conference Board. Compared to the CSI, it uses a larger pool of respondents (5,000) and somewhat different questions.

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, linking time-varying expected returns to macroeconomic variables. In order to distinguish between behavioural 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. We obtain the orthog-

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15 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/.
16 The BWI is formed as the first principal component of 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. 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.
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))
onalized 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. They all rise during the 1990s but start to decline from around 2000, following the culmination of the dot-com boom. Sentiment declines during the recent global financial crisis, but somewhat recovers afterward. While the CCI and CSI are highly correlated, the BWI exhibits different dynamics. For example, the late 1990s dot-com boom episode features more prominently in the BWI, as compared to the survey-based indicators.

In order to examine whether the relationship between stock returns and monetary policy shifts is conditional on the level of investor sentiment, we construct a level-based dummy variable based on the orthogonalized sentiment indexes. The dummy variable, $S_h^t$, 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 at the 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, as discussed in the hypothesis development section.\footnote{Note that we use the terms “following periods of high sentiment” and “high start of the year sentiment” interchangeably throughout the paper.}

Importantly, investor sentiment exhibits a mean-reversion property. 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)). This motivates the construction of a changes-based dummy variable, $S_d^t$, set to 1 (0) during periods of decreasing (increasing) sentiment, that is, years when the sentiment indicator at the December of that year is lower (higher) than at the December of the previous year. Given mean-reversion in sentiment, we expect to obtain qualitatively similar results across the two dummy variables. 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.\footnote{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.}

Figures 3 and 4 plot the sentiment dummies based on levels and changes of the sentiment indexes. The changes-based dummy identifies more regimes than the level based-dummy, while they are both more active than the NBER recession indicator. Specifically, using the CSI, there are 8 instances of the falling sentiment regime and 3 instances of the high (start of the year) sentiment regime. From 2009 onwards, there is no variation in the three level-based dummy variables. They are always equal to 0, indicating low (start of the year) sentiment in the aftermath of the recent financial crisis. The changes-based dummies display some variation during that period, reflecting the fact that the recovery of sentiment has not been strongly sustained.

Table 3 reports the correlation coefficients between the sentiment dummies. Three stylized facts emerge. First, correlations are stronger among the two survey-based measures of sentiment and smaller between them and the BWI proxy. 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 between level- and changes-based sentiment dummies is positive, in line with the idea that sentiment is mean-reverting, and stronger in the case of the CCI (0.41). Third, changes-based sentiment dummies and the NBER recession indicator are positively correlated. This finding reflects periods when decreasing sentiment overlaps with recessionary episodes. As Figures 2 and 4 show, though, declines in sentiment occur not only during recessions but also during expansions.
3.3 Stock returns

We measure daily returns on the stock market, using both CRSP value-weighted and equally-weighted returns, in excess of the 1-month Treasury bill rate between the end of the FOMC meeting day and the end of the previous trading day.

4 Econometric models and results

This section contains event study estimates of the market returns’ responses to monetary policy actions. Section 4.1 analyzes the impact of FFR shocks. Section 4.2 examines the impact of path surprises at the ZLB, while section 4.3 considers announcements of LSAPs and liquidity facilities.

4.1 The impact of target rate surprises

We begin our empirical investigation by examining the market-wide response of stock returns to target FFR surprises on FOMC meeting days conditional on the start-of-the-year level of sentiment. This allows us to test our hypothesis that the effect of monetary policy shocks on the stock market is stronger following periods of high 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 for excess stock returns:

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

where $R_t$ denotes the excess CRSP market return between the FOMC meeting day and the previous trading day.

We use both value- and equally-weighted excess market returns for the estimation of Equation 2 with Newey and West (1987) standard errors. Table 4 reports the estimates for the full sample in Panel A and for pre-crisis periods in Panel B. Starting with value-weighted returns, the Wald test strongly rejects the null hypothesis of equal stock market reaction to monetary policy shocks following periods of low vs. high sentiment ($H_0$: $\beta_1 = \beta_2$). This highlights the presence of a behavioural channel in the transmission of
monetary policy shocks to the stock market.

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 $\beta_2$, is significant, both economically and statistically. The negative sign of $\beta_2$ indicates that following periods of high sentiment the stock market responds positively to monetary easing shocks. Specifically, the results reveal an about 2% 1-day excess stock market return in response to an unexpected cut of 25 basis points in the FFR. On the other hand, when sentiment is low at the start of the year the market response to FFR surprises is statistically insignificant. Hence, in line with our hypothesis, the impact of monetary policy news is stronger following periods of high sentiment. The results are quantitatively similar across the three sentiment indicators, and are robust to the use of the pre-crisis sample period.

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.

Asymmetry: Expansionary surprises vs. tightening surprises

Equation 2 above assumes a symmetric stock market reaction to monetary policy surprises, with no distinction between expansionary shocks and contractionary shocks. In other words, “good news” (unexpected FFR cuts) and “bad news” (unexpected FFR increases) are assumed to affect the stock market in a similar manner. It is plausible, though, that the stock market response depends 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. However, they do not account for sentiment regimes in their empirical framework. To do so, we estimate the following regression model that allows for both sentiment dependence and sign asymmetry:

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

(3)

where $\Delta i_t^{un}$ and $\Delta i_t^{up}$ denote negative and positive unexpected FFR target rate changes,
respectively.\textsuperscript{21}

Table 5 reports estimates of Equation 3 and shows that the reaction of stock market returns to FFR shocks following periods of high sentiment solely materializes in response to expansionary surprises. This effect is captured by $\beta_3$, which is negative and significant at the 1% level across all alternative specifications. The null hypothesis of equal stock market reaction to monetary policy easing shocks following periods of low vs. high statement ($H_0: \beta_1 = \beta_3$) is strongly rejected using the Wald test. On the other hand, the effect of tightening surprises is always statistically insignificant, irrespectively of the state of investor sentiment. These findings highlight that 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.

\textit{Level of sentiment and NBER recessions interacted}

Finally, as previous literature document that the impact of monetary policy is conditional upon the state of economy, we further experimented by interacting the monetary policy coefficient following periods of high sentiment with the NBER recession indicator. By estimating Equation 4, we account for the joint effect of the sentiment’s level and NBER recessions on the reaction of stock market returns to FFR surprises:

\[ R_t = \beta_0 + \beta_1 S^H_t \Delta i^n_t + \beta_2 S^H_t NBER_t \Delta i^n_t + \varepsilon_t \]

where $NBER_t$ is a dummy variable that is equal to 1 if the FOMC meeting occurs during a U.S. recession as classified by NBER business cycle dates , and 0 otherwise.

Table 6 reports the results, and provides further evidence on the important role of sentiment regimes in the transmission of monetary policy shocks to the stock market. In particular, we find that estimates of the interactive term are statistically insignificant. This suggests that the role of investor sentiment is important, distinct from, and not subsumed by, the state of the economy. Estimates of the coefficient of interest ($\beta_1$) are similar in statistical significance, and are very close in magnitude to those reported in

\textsuperscript{21}The negative FFR surprises variable is defined as follows: $\Delta i^n_t = \Delta i^n_t D^n_t$, where $D^n_t$ is a dummy variable that is equal to 1 if $\Delta i^n_t < 0$, and 0 otherwise. In a similar fashion, the positive FFR surprises variable is: $\Delta i^p_t = \Delta i^p_t D^p_t$, where $D^p_t$ is a dummy variable that is equal to 1 if $\Delta i^n_t > 0$, and 0 otherwise.
Table 4, where the sentiment dummy is based on the level on sentiment solely, across alternative proxies of sentiment and sample periods.

Summarizing the market-wide results, we present strong evidence that investor sentiment influences the market-wide reaction of stocks to monetary policy shocks, which is in favour of a behavioural channel for the transmission of monetary policy shocks to the stock market. In line with our hypothesis, we find that the stock market response to monetary policy shocks is concentrated during the price correction phase that follows periods of high sentiment. Moreover, our evidence highlights that the type of monetary policy news that investors are faced with matters, with expansionary surprises being very important, whereas the stock market effect of tightening surprises is insignificant. The state dependence that we identify is related to investor sentiment orthogonalized to economic variation, that is, optimism or pessimism not related to economic developments. Moreover, our findings on the sentiment states and NBER recessions interacted impact also suggest that the role of investor sentiment is not subsumed by the state of the economy. It is therefore distinct in nature to the business cycle effects identified in previous studies (Perez-Quiros and Timmermann (2000); Basistha and Kurov (2008)).

4.2 The impact of path surprises at the zero lower bound

In this section, we start by examining 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 regimes since, as shown in Figure 3, it is equal to zero throughout the ZLB period. On the other hand, the changes-based sentiment dummy exhibits some variation, as displayed in Figure 4. 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 at the ZLB:

\[ R_t = \beta_0 + \beta_1 (1 - S^D_t) path_t + \beta_2 S^D_t path_t + \varepsilon_t \]  

(5)

The findings in Table 7 indicate that, consistent with the evidence from FFR shocks
that we document earlier, the stock market response to path surprises is conditional on the state of investor sentiment. The effect is statistically significant during periods of decreasing sentiment, with the negative sign of $\beta_2$ indicating a positive response to expansionary path surprises. The difference in the stock market response across sentiment regimes is strong, in terms of coefficients’ magnitude and statistical significance of the Wald test. The 1-day excess return in response to an unexpected decline of 25 basis points in the interest rate path during periods of decreasing sentiment is about 1.13%. 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 provide evidence that is consistent with a behavioural channel in the transmission of path surprises.

### 4.3 The impact of LSAPs and liquidity facilities announcements

We examine 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 better identify the announcement effect because this avoids contaminating the impact of one particular announcement with that of previous and subsequent announcements (see also, 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 analyses across each of the sentiment regimes. 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 regimes.\(^{22}\) For example, there are 13 events related to \(^{22}\)As we have already pointed out, the values taken by the CSI and CCI changes-based dummies are the same since 2005.
the announcements of central bank liquidity swaps, 9 of which occur during periods of decreasing sentiment, and the remaining 4 occur during periods of increasing sentiment.\footnote{The announcements related to TAF and liquidity facilities other than central bank liquidity swaps occurred only during periods of decreasing sentiment.}

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):

\[
CSAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} \frac{AR_{i,t}}{S(AR_i)}
\]

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:

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

where \(N\) is the number of observations in the sample.

Table 8 reports that the stock market benefits from the Fed’s establishment of the US dollar and foreign-currency liquidity lines. This effect is conditional, though, 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.\footnote{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.} 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); Rogers, Scotti, and Wright (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.

5 Robustness checks

We conduct a host of robustness checks and our findings remain unchanged. The first three checks involve estimating the impact of FFR shocks and include the removal of FOMC meetings that coincide with employment data releases, using an alternative sample starting period, and employing the index of Huang et al. (2015) to identify sentiment regimes. The fourth check considers an estimation method that is robust to the presence of outliers. The fifth check concerns the approach that we use to identify changes-based sentiment regimes. The sixth uses additional macro-related variables for the orthogonalization of the sentiment indexes. Finally, we use a longer estimation window to investigate the impact of LSAPs and liquidity facilities announcements. The results are contained in the Appendix.

5.1 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 A1). Table A2 shows that the effect of FFR surprises is conditional on the state of investor sentiment, materializing only following periods of high sentiment.
5.2 A sample starting date of 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 target FFR changes, representing a shift that enhanced transparency in monetary policy making. Table A3 report the results. Our findings on the market-wide reaction are overall similar to those from using the sample that begins in June 1989.

5.3 An alternative sentiment measure

Huang et al. (2015) use the partial least squares (PLS) method to develop a new sentiment index, based on an extension of the BWI approach, aiming to align the investor sentiment measure with the purpose of predicting future stock returns. We construct a level-based dummy variable based on the PLS index of Huang et al. (2015) using the same approach as in section 3.2.\textsuperscript{25} We then repeat the analyses for the impact of FFR shocks on market-wide returns and present the results in Table A4. Overall, the results are similar to those from using the other sentiment measures. Specifically, stock market returns react to FFR shocks only following periods of high sentiment.

5.4 Accounting for outliers

We employ the MM weighted least squares regression, using the procedure of Yohai (1987), which is robust to the presence of outliers. Table A5 and A6 report the results for the market-wide response to FFR shocks and path surprises, respectively. In line with the findings from using OLS estimation, the market response to FFR shocks materializes only following periods of high sentiment. Moreover, the impact of path surprises during the ZLB is statistically significant only during periods of decreasing sentiment.

\textsuperscript{25}We did not calculate the changes-based dummy using the PLS index for the same reasons that apply to the BWI index (see the discussion in section 3.2).
5.5 An alternative dummy based on sentiment changes

In the baseline 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 A7 and A8 present the findings for the effects of FFR shocks and 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, with the effect being statistically stronger in the case of FFR surprises.

5.6 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 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).\footnote{\textit{cay} is obtained from Sydney Ludvigson’s website, \url{http://www.econ.nyu.edu/user/ludvigsons/}.}

Table A9 and A10 report the results for the stock market response to FFR shocks and path surprises. 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. Thus, our evidence supports a behavioural explanation.

\subsection*{5.7 A longer estimation window}

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 A11 report the responses of market-wide 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.

\section*{6 Conclusions}

This study contributes to the nascent line of work that seeks to incorporate findings from behavioural finance research about the impact of news on the pricing of stocks, and the established literature that studies the effects of the Fed’s conventional and non-conventional policy actions on financial markets. In classical finance theory, investor sentiment does not play a role in the transmission mechanism of monetary policy news to the stock market. It is solely the state of the economy that matters, with stock returns being more sensitive to policy shifts during recessions (Perez-Quiros and Timmermann (2000)). The evidence in this paper posits a challenge to the rational asset pricing viewpoint by establishing that the stock price reaction to monetary policy news varies with the state of investor sentiment.

To analyze the effect of investor sentiment regimes on the response of stock prices to monetary policy news, we adopt an event study approach. We employ measures of
monetary policy that capture conventional and non-conventional dimensions of the Fed’s behaviour, along with various proxies for investor sentiment. All our evidence suggests that sentiment affects the stock price reaction to monetary policy news. Crucially, we employ sentiment measures that are orthogonalized to a set of macroeconomic variables, and thus, the state dependence we identify is related to optimism or pessimism that is unwarranted by developments in economic fundamentals. It is distinct in nature to the business cycle effects identified in previous studies, and highlights the existence of a separate behavioural channel.

Our evidence supports a sentiment-mispricing mechanism, according to which the stock market becomes overvalued and less rational when sentiment is high. The mispricing is subsequently corrected, leading to lower future returns along with falling sentiment. Our results reveal that the impact of monetary policy shifts on the stock market is concentrated during such periods. Moreover, the type of news that investors are faced with, expansionary vs. contractionary policy shifts, matters. The stock market responds significantly and positively to expansionary monetary policy shocks, while the reaction to tightening surprises is insignificant. Put it differently, “good news”, stemming from expansionary monetary policy decisions, are important to investors when pessimistic sentiment prevails, but not much so when optimism grows.
References


Chen, Shiu-Sheng, 2007, Does monetary policy have asymmetric effects on stock returns?, *Journal of Money, Credit and Banking* 39, 667–688.


Welsch, Roy E, and Edwin Kuh, 1977, Linear regression diagnostics, Discussion paper.


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

$\Delta i_t$ and $\Delta i^u_t$ denote FFR target rate changes and unexpected changes, respectively, on FOMC meeting dates over the full sample period (June 1989 - October 2014). $path_t$ denotes path surprises on FOMC meeting dates over the zero lower bound period (January 2009 - October 2014).

<table>
<thead>
<tr>
<th>Obs</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>St.Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: All meetings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta i_t$</td>
<td>227</td>
<td>-0.75</td>
<td>0.75</td>
<td>-0.04</td>
</tr>
<tr>
<td>$\Delta i^u_t$</td>
<td>227</td>
<td>-0.42</td>
<td>0.17</td>
<td>-0.02</td>
</tr>
<tr>
<td>$path_t$</td>
<td>47</td>
<td>-0.62</td>
<td>0.46</td>
<td>-0.01</td>
</tr>
<tr>
<td>Panel B: Contractionary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta i_t &gt; 0$</td>
<td>31</td>
<td>0.25</td>
<td>0.75</td>
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<tr>
<td>$\Delta i^u_t &gt; 0$</td>
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<td>0.003</td>
<td>0.17</td>
<td>0.05</td>
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<tr>
<td>$path_t &gt; 0$</td>
<td>17</td>
<td>0.003</td>
<td>0.46</td>
<td>0.10</td>
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<tr>
<td>Panel C: Expansionary</td>
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<tr>
<td>$\Delta i_t &lt; 0$</td>
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<tr>
<td>$\Delta i^u_t &lt; 0$</td>
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<td>$path_t &lt; 0$</td>
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<tr>
<td>Panel D: No change</td>
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<td>$\Delta i_t = 0$</td>
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<tr>
<td>$path_t = 0$</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 2: LSAPs and liquidity facilities announcements

This table considers 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/).

<table>
<thead>
<tr>
<th>Announcement</th>
<th>Obs</th>
<th>Date of first announcement</th>
<th>Date of last announcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquidity facilities</td>
<td>46</td>
<td>12/12/2007</td>
<td>31/10/2013</td>
</tr>
<tr>
<td>Central bank liquidity swaps</td>
<td>13</td>
<td>12/12/2007</td>
<td>31/10/2013</td>
</tr>
<tr>
<td>Term auction facility</td>
<td>13</td>
<td>12/12/2007</td>
<td>28/08/2009</td>
</tr>
<tr>
<td>Other liquidity facilities</td>
<td>21</td>
<td>03/11/2008</td>
<td>04/12/2009</td>
</tr>
<tr>
<td>LSAPs</td>
<td>22</td>
<td>25/11/2008</td>
<td>30/10/2013</td>
</tr>
</tbody>
</table>
Table 3: Correlation matrix of sentiment regimes

This table presents the correlation coefficients of the sentiment-based dummy variables and the NBER recession dummy. $S_{t}^{H,i}$ 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 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. $i = CSI$ 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. The sample period is June 1989 - October 2014. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

<table>
<thead>
<tr>
<th></th>
<th>$S_{t}^{H,CSI}$</th>
<th>$S_{t}^{D,CSI}$</th>
<th>$S_{t}^{H,CCI}$</th>
<th>$S_{t}^{D,CCI}$</th>
<th>$S_{t}^{H,BWI}$</th>
<th>$NBER_{t}$</th>
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<td>$S_{t}^{H,CCI}$</td>
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<td>$S_{t}^{D,CCI}$</td>
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<td>0.41***</td>
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<tr>
<td>$S_{t}^{H,BWI}$</td>
<td>0.50***</td>
<td>0.19***</td>
<td>0.49***</td>
<td>0.05</td>
<td>1.00</td>
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<tr>
<td>$NBER_{t}$</td>
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<td>0.37***</td>
<td>0.02</td>
<td>0.37***</td>
<td>0.05</td>
<td>1.00</td>
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</table>
Table 4: Response of stock market returns to FFR shocks following periods of high vs. low sentiment

This table presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors, over FOMC meeting dates of the following model: \( R_t = \beta_0 + \beta_1 (1 - S^H_t) \Delta i_t + \beta_2 S^H_t \Delta i_t + \varepsilon_t \), where \( R_t \) and \( \Delta i_t \) denote CRSP market returns (value-weighed and equally-weighted, alternatively) in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. \( S^H_t \) 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. 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 A and B include the full sample (June 1989 - October 2014) and pre-crisis (June 1989 - August 2007) FOMC meetings, respectively, with the exception of the 17 September 2001 meeting, the 22 January 2008 meeting and the unscheduled meetings that were not accompanied by a FOMC statement or other information. Standard errors are reported in parentheses. P-values from the Wald test for equality of coefficients (F-statistic) in square brackets. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

<table>
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<tr>
<th></th>
<th>Value weighted returns</th>
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<th>Equally weighted returns</th>
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<td>Obs  β₀  β₁  β₂  β₁ = β₂  Adj.R²</td>
<td>β₀  β₁  β₂  β₁ = β₂  Adj.R²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSI</td>
<td>227 0.24*** -0.33 -7.04*** [0.00] 0.11</td>
<td>0.20*** -0.57 -4.50** [0.08] 0.06</td>
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<td></td>
<td>(0.09) (0.84) (2.40)</td>
<td>(0.08) (0.62) (2.23)</td>
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<tr>
<td>CCI</td>
<td>227 0.24*** -0.48 -7.22*** [0.00] 0.11</td>
<td>0.19** -0.51 -4.78** [0.06] 0.06</td>
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<tr>
<td></td>
<td>(0.09) (0.82) (2.48)</td>
<td>(0.08) (0.60) (2.27)</td>
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<td></td>
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</tr>
<tr>
<td>BWI</td>
<td>227 0.26*** -0.32 -6.72*** [0.01] 0.10</td>
<td>0.21*** 0.51 -5.36*** [0.00] 0.09</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.09) (0.89) (2.53)</td>
<td>(0.07) (0.77) (1.88)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel B: Pre-crisis</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CSI</td>
<td>168 0.15 -0.57 -8.54*** [0.00] 0.25</td>
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<tr>
<td></td>
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<td>(0.06) (0.61) (2.14)</td>
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<td></td>
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<td>(0.06) (0.60) (2.12)</td>
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<tr>
<td>BWI</td>
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<td>0.13** 0.28 -6.23*** [0.00] 0.26</td>
<td></td>
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<td></td>
<td>(0.08) (0.91) (2.23)</td>
<td>(0.05) (0.79) (1.71)</td>
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</table>
Table 5: Response of stock market returns to negative and positive FFR shocks following periods of high vs. low sentiment

This table presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors, over FOMC meeting dates of the following model: \( R_t = \beta_0 + \beta_1 (1 - S_t^H) \Delta i_{t}^{un} + \beta_2 (1 - S_t^H) \Delta i_{t}^{up} + \beta_3 S_t^H \Delta i_{t}^{un} + \beta_4 S_t^H \Delta i_{t}^{up} + \epsilon_t \), where \( R_t \), \( \Delta i_{t}^{un} \) and \( \Delta i_{t}^{up} \) 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 \( \Delta i_{t}^{un} = \Delta i_{t}^{Dn} \), where \( \Delta i_{t}^{Dn} \) is a dummy variable that is equal to 1 if \( \Delta i_{t}^{un} < 0 \), and 0 otherwise. Positive FFR surprises are calculated as \( \Delta i_{t}^{up} = \Delta i_{t}^{Dp} \), where \( \Delta i_{t}^{Dp} \) is a dummy variable that is equal to 1 if \( \Delta i_{t}^{up} > 0 \), 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. 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 A and B include the full sample (June 1989 - October 2014) and pre-crisis (June 1989 - August 2007) FOMC meetings, respectively, with the exception of the 17 September 2001 meeting, the 22 January 2008 meeting and the unscheduled meetings that were not accompanied by a FOMC statement or other information. Standard errors are reported in parentheses. P-values from the Wald test for equality of coefficients (F-statistic) in square brackets. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

<table>
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<tr>
<th></th>
<th>Obs</th>
<th>( \beta_0 )</th>
<th>( \beta_1 )</th>
<th>( \beta_2 )</th>
<th>( \beta_3 )</th>
<th>( \beta_4 )</th>
<th>( \beta_1 = \beta_3 )</th>
<th>( \beta_2 = \beta_4 )</th>
<th>Adj.R(^2)</th>
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<td>( \text{Panel A: Full sample} )</td>
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<td>0.11</td>
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<td>-0.24</td>
<td>-9.52***</td>
<td>5.48</td>
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<td>(1.50)</td>
<td>(6.47)</td>
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<tr>
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<td>-0.58</td>
<td>-9.50***</td>
<td>8.00</td>
<td>[0.00]</td>
<td>[0.28]</td>
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<td>(1.50)</td>
<td>(7.33)</td>
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<td>BWI</td>
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<td>5.06</td>
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<td>(0.93)</td>
<td>(6.07)</td>
<td>(1.84)</td>
<td>(5.48)</td>
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</tr>
<tr>
<td>( \text{Panel B: Pre-crisis} )</td>
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<td>168</td>
<td>0.06</td>
<td>-1.01</td>
<td>0.28</td>
<td>-9.78***</td>
<td>-1.11</td>
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<td>(0.80)</td>
<td>(4.55)</td>
<td>(1.52)</td>
<td>(4.17)</td>
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<tr>
<td></td>
<td>CCI</td>
<td>168</td>
<td>0.07</td>
<td>-1.03</td>
<td>-0.12</td>
<td>-9.70***</td>
<td>-1.28</td>
<td>[0.00]</td>
<td>[0.88]</td>
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<td></td>
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<td>(0.81)</td>
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<td>(1.52)</td>
<td>(6.75)</td>
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<tr>
<td></td>
<td>BWI</td>
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<td>-1.58</td>
<td>6.00</td>
<td>-9.22***</td>
<td>-3.74</td>
<td>[0.00]</td>
<td>[0.16]</td>
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<td>(0.94)</td>
<td>(6.28)</td>
<td>(1.91)</td>
<td>(3.64)</td>
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</tr>
</tbody>
</table>
Table 6: Response of stock market returns to FFR shocks following periods of high sentiment and recessions

This table presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors, over FOMC meeting dates of the following model: \( R_t = \beta_0 + \beta_1 S_H^t \Delta_i u_t + \beta_2 S_H^t NBER_t \Delta_i u_t + \epsilon_t \), where \( R_t \) and \( \Delta_i u_t \) denote CRSP value-weighted market returns in excess of the 1-month Treasury bill rate and unexpected FFR changes, respectively. \( S_P^t \) is a dummy variable that is equal to 1 if the FOMC meeting occurred during a decreasing sentiment year and 0 otherwise. \( S_H^t \) 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. 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. \( NBER_t \) 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. Panel A and B include the full sample (June 1989 - October 2014) and pre-crisis (June 1989 - August 2007) FOMC meetings, respectively, with the exception of the 17 September 2001 meeting, the 22 January 2008 meeting and the unscheduled meetings that were not accompanied by a FOMC statement or other information. Standard errors are reported in parentheses. P-values from the Wald test for equality of coefficients (F-statistic) in square brackets. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Obs</th>
<th>( \beta_0 )</th>
<th>( \beta_1 )</th>
<th>( \beta_2 )</th>
<th>( \beta_1 = \beta_2 )</th>
<th>Adj. ( R^2 )</th>
</tr>
</thead>
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<tr>
<td><strong>Panel A: Full sample</strong></td>
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<tr>
<td>CSI</td>
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<td>-8.20***</td>
<td>3.14</td>
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<td>(2.29)</td>
<td>(4.64)</td>
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</tr>
<tr>
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<td>227</td>
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<td>-8.55***</td>
<td>3.47</td>
<td>[0.04]</td>
<td>0.11</td>
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<tr>
<td></td>
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<td>(0.09)</td>
<td>(2.35)</td>
<td>(4.66)</td>
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</tr>
<tr>
<td>BWI</td>
<td>227</td>
<td>0.26***</td>
<td>-7.65***</td>
<td>2.64</td>
<td>[0.12]</td>
<td>0.10</td>
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<tr>
<td></td>
<td></td>
<td>(0.08)</td>
<td>(2.77)</td>
<td>(4.90)</td>
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<tr>
<td><strong>Panel B: Pre-crisis</strong></td>
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<td></td>
</tr>
<tr>
<td>CSI</td>
<td>168</td>
<td>0.16*</td>
<td>-8.00***</td>
<td>-1.65</td>
<td>[0.19]</td>
<td>0.25</td>
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<td>(2.48)</td>
<td>(2.43)</td>
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<td>-8.40***</td>
<td>-1.29</td>
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<td>(2.55)</td>
<td>(2.50)</td>
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<tr>
<td>BWI</td>
<td>227</td>
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<td>-7.37**</td>
<td>-2.23</td>
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<td>0.23</td>
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<td>(0.08)</td>
<td>(2.95)</td>
<td>(2.92)</td>
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<td></td>
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</table>
Table 7: Response of stock market returns to path surprises at the zero lower bound during periods of decreasing vs. increasing sentiment

This table presents OLS estimates with heteroscedasticity and autocorrelation consistent standard errors, over FOMC meeting dates of the following model: $R_t = \beta_0 + \beta_1 (1 - S^P_t) path_t + \beta_2 S^P_t path_t + \epsilon_t$, 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. $S^P_t$ 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 sample period is January 2009 - October 2014. The unscheduled meetings that were not accompanied by a FOMC statement or other information were excluded. Standard errors are reported in parentheses. P-values from the Wald test for equality of coefficients (F-statistic) in square brackets. *, **, *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

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<th>$\beta_1$</th>
<th>$\beta_2$</th>
<th>$\beta_1 = \beta_2$</th>
<th>Adj. $R^2$</th>
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</thead>
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<td>47</td>
<td>0.25*</td>
<td>0.45</td>
<td>-4.51***</td>
<td>[0.61]</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.64)</td>
<td>(1.74)</td>
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</table>

42
Table 8: Response of stock market returns to LSAPs and liquidity facilities announcements during periods of decreasing vs. increasing 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 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, including 13 announcements about central bank (CB) liquidity swaps, 13 announcements about the term auction facility (TAF) and 21 announcements about other liquidity facilities (others). 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.

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<tr>
<th>Event window</th>
<th>Liquidity facilities (All)</th>
<th>CB liquidity swaps</th>
<th>TAF</th>
<th>Others</th>
<th>LSAPs</th>
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</tr>
<tr>
<td>(-1, 3)</td>
<td>-0.14</td>
<td>3.17</td>
<td>-1.92</td>
<td>-0.74</td>
<td>1.49</td>
</tr>
<tr>
<td>(-1, 1)</td>
<td>0.55</td>
<td>3.11**</td>
<td>-0.74</td>
<td>0.10</td>
<td>1.87</td>
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<td>(0, 0)</td>
<td>0.16</td>
<td>1.51***</td>
<td>-0.42</td>
<td>-0.06</td>
<td>0.08</td>
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<tr>
<td>Panel B: Increasing sentiment</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(-1, 3)</td>
<td>0.77</td>
<td>0.77</td>
<td>-</td>
<td>-</td>
<td>-0.64</td>
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<td>(-1, 1)</td>
<td>0.22</td>
<td>0.22</td>
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<td>(0, 0)</td>
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<td>0.96</td>
<td>-</td>
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<td>-0.04</td>
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</table>
Figure 1: Actual and unexpected FFR changes

This figure plots actual and unexpected FFR changes on FOMC meeting dates over the period June 1989 - October 2014. Shaded areas denote U.S recessions as classified by NBER business cycle dates.
Figure 2: Sentiment indices

This figure plots sentiment indices using monthly data over the period December 1988 - 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 regimes

This figure plots level-based sentiment dummy variables, $S_t^{H,i}$, over the period December 1988 - October 2014. The 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. $i = \text{CSI, CCI and BWI}$; 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 regimes

This figure plots changes-based sentiment dummy variables, $S_{i,t}^{D,j}$, over the period January 1989 - October 2014. The dummy variable 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. $i =$ 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.