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JEL Classification: G10, G12, E44

Keywords: Monetary Policy Surprises, Equity premium, Fund flows, Portfolio rebalancing, Price pressure

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The FOMC Risk Shift*

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Abstract

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1. Introduction

US monetary policy announcements are one of the most anticipated news events and are well known for frequently triggering large movements in stock prices. That being the case, previous academic studies focusing on the response of equity returns to changes in risk-free interest rates typically account for only a small share of these large stock price movements. For example, the seminal work by Bernanke and Kuttner (2005) concludes that "only a small portion of the overall variability of stock prices" around FOMC announcements of less than 20% is explained by changes in risk-free rates. Studies using more recent samples and high frequency data confirm this finding (e.g., Gorodnichenko and Weber (2016)). So what drives the other 80%?

We argue that it is not surprising that changes in risk-free rates only explain a relatively small fraction of stock returns around FOMC announcements. A large literature shows, empirically and theoretically, that risk-free rates do not span equity risk premia (see, e.g., Campbell (2017) for a summary), and it is well known that the effects of monetary policy go beyond changes in risk-free interest rates. Thus it seems reasonable to expect that a sizeable portion of monetary policy news relevant to the pricing of risky assets is not captured by changes in risk-free rates.

As a first contribution, we thus go beyond risk-free rates to capture the various dimensions of monetary policy surprises. We do so by augmenting a cross-section of short and long-term risk-free interest rates with a set of risky asset prices (such as the VIX, CDS premia and the US dollar) in an otherwise standard factor analysis to extract monetary policy surprises from high-frequency market prices.[1] The first two components of monetary policy surprises we extract in this way capture short and long term interest rate surprises similar to the earlier literature (Bernanke and Kuttner (2005), Gürkaynak, Sack, and Swanson (2005), Hanson and

[1] There is a large and growing literature on the link between different dimensions of monetary policy and asset prices. See, e.g., Shiller, Campbell, and Schoenholtz (1983) for an early contribution, and Bernanke and Kuttner (2005) as well as Gürkaynak, Sack, and Swanson (2005) for some further seminal work. A non-exhaustive set of more recent contributions includes Adrian and Shin (2010), Borio and Zhu (2012), Bekaert, Hoerova, and Duca (2013), Morris and Shin (2014), Hanson and Stein (2015), Gertler and Karadi (2015), Hattori, Schrimpf, and Sushko (2016), Gorodnichenko and Weber (2016), Schmeling and Wagner (2019), Leombroni, Vedolin, Venter, and Whelan (2016), Adrian and Liang (2016), Neuhierl and Weber (2016), Ozdagli and Weber (2016), Swanson (2018)), Boyarchenko, Haddad, and Plosser (2017), or Drechsler, Savov, and Schnabl (2017), among others. A common finding in this literature is that monetary policy affects equity prices. The crucial point in our paper is that there is a component of monetary policy news that is *unrelated* to risk-free bond yield changes.

Stein (2015), Swanson (2018)). Our third surprise component, which we label "FOMC risk shifts", is new and captures the response of risk premia that is common to various risky assets but orthogonal to changes in risk-free interest rates *by construction*. Variation in our risk shift variable is reminiscent of "risk on/off" switches in investor risk tolerance in the sense that a positive risk shift is associated with a lower VIX, lower CDS spreads, and a weaker US dollar.

A second contribution of our analysis is to go beyond pure asset price effects by additionally investigating the response of quantities to monetary policy news. Bernanke and Kuttner (2005) already conclude that "the large movement in excess returns associated with monetary policy" might also reflect, at least in part, "excess sensitivity or overreaction of stock prices to policy actions". Our analysis addresses this open question by studying fund flows and trading volumes triggered by exchange traded fund (ETF) investors around FOMC announcements.[2] We perform this analysis at a daily frequency (which is the highest available frequency for ETF flows), in order to link fund flows to high frequency monetary policy surprises. Large fund flows around FOMC announcements indicate that one group of investors must buy (or sell) from another group of investors, suggesting that investors react heterogeneously to monetary policy news.[3] Moreover, flows allow us to study the actual portfolio rebalancing between risky and safe assets in the US as well as internationally. To the best of our knowledge, studying positioning changes and flows around FOMC announcements, and thus quantifying the extent to which investors react heterogeneously to specific monetary policy surprises, is a novel feature of our analysis.

Our first key finding is that FOMC risk shifts are the main driver of equity returns on FOMC announcement days such that positive FOMC risk shifts are associated with significantly positive equity returns. For example, a one-standard deviation FOMC risk shift corresponds to an initial equity excess return of 0.70% (t-stat: 15.4) in a short window around the FOMC announcement. Moreover, FOMC risk shifts account for about 72% of the event window variation in equity returns. In stark contrast, traditional short rate and long rate surprises together account for

[2]Other recent papers that stress the importance of using fund flows to gauge investors' expectations and preferences include, e.g., Jotikasthira, Lundblad, and Ramadorai (2012), Greenwood and Shleifer (2014), Ben-Rephael, Kandel, and Wohl (2012), Berk and van Binsbergen (2016).

[3]Bollerslev, Li, and Xue (2018) study the relationship between trading volume and return volatility for various macroeconomic announcements. They argue that the observed relationship is in line with models that allow for disagreement between investors.

less than 10% of the variation in equity returns in our sample, which is in line with the most recent estimates by others (e.g., Gorodnichenko and Weber (2016)).[4] In addition, we document that FOMC risk shifts also trigger a sizeable response of ETF fund flows, suggesting a strong rebalancing by some market participants to more risky assets ("risk on") or safer assets ("risk off").

When we study the persistence in the response of prices and flows, we find that the initial response on FOMC announcement days has a large transitory component. That is, a large part of the price and quantity response to FOMC risk shifts is reversed after about four weeks. This second key finding suggests that the reaction of prices and quantities observed around FOMC risk shifts is mostly temporary in nature and is unlikely to be fully explained by changes in (expected) fundamentals.

Importantly, the strong effect of FOMC risk shifts on prices and quantities is not limited to US equity markets as we document similar effects for other risky asset classes, such as corporate bonds, high yield bonds, or emerging market assets. Thus, our results show that risk shifts have a significant impact on international asset allocations in general.

We consider several robustness checks of our main results. For example, risk shifts measured around the release of monetary policy news significantly differ from "pseudo risk shifts" drawn from a control group of event windows that do not contain monetary policy news. We verify that neither the specific sample period in our main analysis nor the financial crisis episode drives our results. We also find similar results when considering sensible variations in the event window and alternative ways to construct risk shifts.

[4] A recent stream of literature looks at average returns on or around FOMC announcement days. For example, Savor and Wilson (2013) find significant average US excess stock returns on macroeconomic announcement days, including scheduled FOMC days. Lucca and Moench (2015) detect a price drift ahead of FOMC announcements and find that the entire US equity premium is earned around scheduled FOMC events. Brusa, Savor, and Wilson (2016) provide international evidence on this pattern and Mueller, Tahbaz-Salehi, and Vedolin (2017) study exchange rates in the context of FOMC meetings. A few papers study the longer-term effects of FOMC news on returns. For example, Cieslak, Morse, and Vissing-Jorgensen (2018) detect a cycle in equity returns following the FOMC meeting schedule. Neuhierl and Weber (2017) document a drift around FOMC announcements starting 15 days before the announcement. We complement this literature by focusing on the variation of returns (i.e., the news component of FOMC announcements), instead of looking at average returns.

What economic mechanism can explain our findings? At the outset, fundamental stock price movements must come from news about future dividends, or future expected returns (Campbell and Shiller (1988), and Campbell (1991)). However, if we allow for the possibility that investors react heterogeneously to news, a fundamental shock might also be amplified by temporary price pressures (e.g., Scholes (1972); Stoll (1978); Grossman and Miller (1988)).

We run a host of tests to better understand these potential economic mechanisms driving our empirical results. We start with the standard vector autoregression (VAR) approach (Campbell and Shiller (1988), Campbell (1991)) to decompose daily stock return innovations into changes in risk premia and a residual. The predictors in the VAR include measures of near-future expected returns.[5] More specifically, we employ the variance risk premium (Bollerslev, Tauchen, and Zhou (2009)) and the lower bound on the expected equity premium implied by option prices (the SVIX-based measure of the equity premium in Martin, 2017). Based on this setup, we show that up to 44% of the stock return reaction to FOMC risk shifts is driven by changes in risk premia. The remaining 56% are left as unexplained residual. This residual component is highly transitory, and thus cannot represent news about future dividends as theory predicts that this component should be much more persistent.

However, the large ETF trading volumes and fund flows observed around FOMC risk shifts suggest that investors react heterogeneously to monetary policy news. Thus, a plausible explanation is that the impact of news about fundamentals on stock prices is amplified by price pressure due to rebalancing demands from a subset of investors. To further investigate this hypothesis, we estimate the price pressure effects stemming from ETF fund flows directly. These results indicate that fund flow-induced price pressure accounts for about 40% of the initial response. We conclude that our results put a lower bound of 40% (directly estimated) and an upper bound of 56% (indirectly estimated) on the role of price pressures.

A key question remains, however, which is *why* investors react heterogeneously to the monetary policy surprises captured by FOMC risk shifts, such that we observe large trading volume

[5] A few earlier papers (see, e.g., Hattori, Schrimpf, and Sushko, 2016; Boguth, Gregoire, and Martineau, forthcoming; Fernandez-Perez, Frijns, and Tourani-Rad, 2017; Mueller, Tahbaz-Salehi, and Vedolin, 2017; Ai and Bansal, 2018, for related papers) study empirically, or theoretically, how uncertainty (as measured by, e.g., the VIX) reacts on FOMC announcement days.

and rebalancing of risky assets. To this end, we rely on an analysis of news article sentiment and textual analysis of market commentary. If the FOMC risk shifts documented in this paper reflect that certain groups of (presumably more active) investors seek greater exposure to risk, by entering into a "risk on" mode, we should observe that news sentiment around such FOMC days becomes more positive. Using sentiment scores from the *Ravenpack News Analytics* database on articles related to the Federal Reserve, we find that positive FOMC risk shifts correlate with more positive news articles.[6]

Finally, we complement the sentiment score approach by a qualitative analysis of market commentary on FOMC announcement days. To this end, we collect market commentary from experts (e.g., traders, analysts, economists) on the outcome of the meeting shortly after an FOMC announcement. Our analysis suggests that when the Fed delivers a policy action confirming the prior views of market participants, we observe a positive risk shift and market participants enter into a "risk on" mode and vice versa.

A plausible interpretation of these results is that the short term dynamics around FOMC announcements are shaped by the interactions of heterogeneous investors. Market participants naturally differ in their rebalancing frequency and investment horizons. Some players rebalance their portfolios frequently and may adjust their positioning based on monetary policy news. Other players, by contrast, play a more passive role by just absorbing such flows (e.g., market makers but also (longer term) investors who need to be incentivized to take the other side). Our results suggest that monetary policy news that does not conform with the priors of active traders leads to a drop in their willingness to take risks, a reduction in sentiment and a rebalancing away from risky assets. Such negative risk shifts ("risk off") go hand in hand with a surge in trading volume and price pressure to induce the passive investors to absorb these flows, which is subsequently reverted. Opposite patterns ("risk on") are observed in the case of the central bank's action conforming with active traders' priors.

[6] See, e.g., Asness, Liew, Pedersen, and Thapar (2019) for another paper that relies on Ravenpack sentiment scores in a different context.

2. Monetary policy surprises

2.1. Motivation

We are interested in the channels through which news about monetary policy affects stock prices. To illustrate our approach, we consider a standard present-value decomposition of returns (Campbell (1991)):

$$r_{t+1} - E_t r_{t+1} \cong (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \triangle d_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \left(rf_{t+1+j} + rp_{t+1+j} \right). \quad (1)$$

The present-value logic implies that surprises in stock returns must come from (i) news about future dividends ($\triangle d_{t+1+j}$), (ii) changes in the risk-free component of discount rates (rf_{t+1+j}), and (iii) changes in the risk premium component of discount rates (rp_{t+1+j}). This identity tells us that if stock prices respond to monetary policy news, the effect must be operating through either one (or a combination of) these three channels. The key question is which of these channels are empirically important.

Our goal is to quantitatively measure the return component which moves the most upon the revelation of monetary policy news and thereby to isolate the economic forces driving the stock market response. Monetary policy is commonly thought to move stock prices either *directly* via the risk-free rate channel, or *indirectly* by carrying news about future dividends or inducing changes in required risk compensations.

Although surprises in risk-free rates might carry some news about future dividends and even risk premia, it is a well-established finding that risk-free rates do not fully span risk premia (e.g., Cochrane (2005), Campbell (2017), Ferson (2019) for a summary). In line with this reasoning, Bernanke and Kuttner (2005) already concluded that "only a small portion of the overall variability of stock prices" is explained by surprises in monetary policy rates. It is particularly this part of the stock market response – the component unexplained by interest rates – that we are interested in this paper. To gain a better understanding of that component, we hence depart from the extant literature that has focused on changes in risk-free rates in the measurement of monetary policy surprises.

2.2. Construction

Following the argument above, our goal is to extract monetary policy suprises that are *orthogonal* to risk-free rates and bond yields. We do so by means of a factor analysis on FOMC announcement days following the methodology put forth in Gürkaynak, Sack, and Swanson (2005) and Swanson (2018). Crucial to our approach is to expand the set of assets beyond traditional changes in interest rates when gauging monetary policy surprises. We employ a broad cross-section of changes in 3-months rates, as well as 2-, 5- and 10-year Treasury yields implied by futures prices. But most importantly, we expand this set of risk-free assets with a cross-section of risky asset prices. In particular, we add changes in CDS spreads (CDX corporate investment grade index), changes in the value of a broad US dollar index (for which a higher reading means an appreciation of the US dollar), as well as changes in S&P500 option implied volatility (VIX) to the analysis (see, e.g., Boguth, Gregoire, and Martineau, forthcoming; Fernandez-Perez, Frijns, and Tourani-Rad, 2017; Mueller, Tahbaz-Salehi, and Vedolin, 2017, for related papers).[7]

The three risk proxies are directly derived from market prices, i.e., they are able to quickly respond to news, which is an important feature for our subsequent analysis, and we can measure them at high frequencies. Moreover, it is well understood that these asset prices are very sensitive to changes in investors' perceptions and required compensations for risk. Bollerslev, Tauchen, and Zhou (2009) and Martin (2017) show that changes in option implied volatility are linked to changes in the equity risk premium under rather general conditions. Merton (1974) and recently Seo and Wachter (2018) show that the credit risk premium is theoretically affected by factors common to the equity premium. The recent literature has argued that movements in the dollar are related to monetary policy uncertainty Mueller, Tahbaz-Salehi, and Vedolin (2017) and, more generally, have become an important barometer of risk Avdijev, Du, Koch, and Shin

[7]Over large parts of our sample, the ultra-short end of the yield curve was constrained by the effective lower bound on interest rates. Thus, we do not include overnight interest rates or futures on Fed funds rates in this exercise to extract monetary policy surprises. The robustness section compares our results to monetary policy surprises based on Fed funds futures for the period prior to the effective lower bound.

(2017).

We take a comprehensive view and collect intraday data on days with scheduled (# 96) and unscheduled (# 2) FOMC announcements between 2006 and 2017, for which detailed data on prices (and fund flows) are available.[8] We then measure the change of the seven variables within an event window of 90 minutes (-15m:+75m) around FOMC announcements. Since 2011, the FOMC frequently holds a press conference about one up to two hours after the actual announcement. Recent evidence suggest that press conferences carry important information for investors (e.g., Boguth, Gregoire, and Martineau (forthcoming) and Cieslak and Schrimpf (2018)). In these cases (28), we extend the event window to the closing price (16:15) of the FOMC announcement day.[9] We use log changes of the three risky asset prices to reduce the impact of heteroscedasticity and standardize all seven variables based on their FOMC day standard deviation.

>>> TABLE 1 ABOUT HERE <<<

To extract monetary policy surprises, we then run a principal component analysis (PCA) of the asset price changes at high frequency. The left hand side of Table 1 shows that the first three principal components explain more than 80% of the variances of the seven variables. However, the three factors are purely determined by how much variance they explain. Thus, to obtain monetary policy surprises that are easier to interpret economically, we apply an orthogonal factor rotation on the first three principal components (e.g., Swanson (2018)).

Table 1 shows that the first rotated factor targets the front-end of the yield curve. The second targets the remaining long-term bond yields. Finally, the third factor targets the market-based risk proxies (VIX, CDS prices and the US dollar). This factor is orthogonal to the two yield-based factors *by construction*. It hence captures monetary policy news that is not spanned by yields, which is our main focus of interest as discussed above.

[8] We provide robustness based on a longer sample periods going back to 1998 (with less detailed data) later in the paper. Our event list is available in the Internet Appendix, Table IA.4.

[9] The robustness section provides results for (i) tighter and wider event windows, (ii) ignoring press conferences, (iii) removing the financial crisis, or (iv) the period where rates are close to the effective lower bound from the sample.

2.3. Interpretation of rotated factors

The loadings on the rotated factors are reported on the right hand side of Table 1. Based on the loading patterns, we characterise the three monetary policy surprises as follows:

(1) "*Short Rate Surprises*": The first factor primarily loads on 3-month, and 2-year yields and has low loadings on all other variables. It is mildly exposed to the market-based risk proxies. This surprise measure thus mostly captures changes in the central bank's policy target as well as expectations of its evolution over the nearer term.

(2) "*Long Rate Surprises*": The second factor loads particularly on 5-year and 10-year yields. Thus it is likely to capture the effects stemming from news about asset purchases that affect the yields on long term bonds through signalling and/or portfolio rebalancing channels. In a similar vein, this factor will capture effects of explicit forward guidance affecting expectations at longer horizons. While it has basically no exposure to short-term yields, it is somewhat exposed to the market-based risk proxies. However, these exposures are small in magnitude and also have opposing signs (negative for VIX, but positive for the US dollar) so that there is no clear link to risky asset prices.

(3) "*Risk Shifts*": The third factor loads consistently negatively on all three market-based risk proxies, but does not load strongly on any of the four yields. A rise in this surprise measure goes along with a drop in the VIX, a weakening of the Dollar, and a compression in CDS premia. A positive reading of this surprise variable thus seems to suggest that the market has entered into a "risk on mode". We label this policy surprise a "risk shift" in the following.

To be clear, the labels we assign to the monetary policy surprises are purely descriptive and simply indicate on which asset prices they predominantly load. We investigate the possible economic mechanisms driving these surprises more closely in Section 4 below.

Illustration: We plot the realizations of *Risk Shifts* (standardized to a unit standard deviation) in event time for the 98 FOMC announcements in our sample in Figure 1. Plots for the more familiar short-rate and the long-rate surprises can be found in the Internet Appendix (Figure IA.2 and IA.3).

>>> FIGURE 1 ABOUT HERE <<<

Interestingly, we observe large risk shifts on several days with important monetary news, even though risk shifts are by construction uncorrelated with movements in short- and long-term yields. For example, we find that risk shifts are positive on key announcements related to the introduction of QE2 and QE3. While interest rates barely moved on these announcements, the market response of risky assets suggests that markets entered into a "risk on" mode and that required risk compensations fell. By contrast, we observe a negative risk shift realization on the announcement of an unscheduled cut of interest rates by 75 bp in January 2008. Likewise, we find a large negative risk shift in mid-2013 when FOMC Chair Bernanke alluded to the possibility that the Federal Reserve might slow down its asset purchases (an episode known as the taper tantrum). These examples serve to show that risk shifts are clearly driven by monetary policy news, but that they capture a dimension of policy news that is not spanned by yields.

Robustness: Since our approach of extracting (rotated) factors is crucial for the remainder of our paper, we provide several additional checks to document that our measure of risk shifts is robust and meaningful. We show that (i) the third (rotated) factor is not simply identical to the VIX by conducting a "leave-one-out"-analysis where we sequentially exclude one of the three asset prices when constructing our factors (see Figure 8). (ii) We verify our approach by "reverse-engineering" how the seven assets might load on "true" short-rate, long-rate, and risk shift factors and some asset specific noise such that a factor analysis leads to similar results. We indeed find a plausible structure in this exercise presented in Section IA.C in the Internet Appendix. (iii) We run a simulation experiment and compare the extracted monetary policy surprises with the "true" monetary policy surprises. Our results indicate that the factor analysis employed in this section is indeed able to filter the "true" factors with high accuracy (Section IA.C). (iv) We show that a simple regression-based orthogonalization leads to similar results as the PCA-based factor analysis (Figure IA.8).

2.4. Fund flows and other data

Fund flows: A novel angle in this paper is to study how quantities respond to monetary policy news alongside with that of prices. To this end, we collect daily ETF (and mutual fund) data from TrimTabs. We aggregate individual funds to asset classes. Our measure for US equity is based on all funds that belong to Morningstar's category "Blend". We construct flows for other asset classes in the same way. Fund flows at the asset class level are measured as:

$$F_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1}\left(1 + R_{i,t}\right)}{TNA_{i,t-1}}, \tag{2}$$

where $TNA_{i,t}$ are total net assets of asset class i (e.g., equities) at time t, and $R_{i,t}$ is the fund return of asset class i. Because fund flows do not have an economically meaningful long-run mean or standard deviation, we apply a normalization of flows (see, e.g., Berk and van Binsbergen (2016), Menkhoff, Sarno, Schmeling, and Schrimpf (2016)). We rescale all flows to a zero mean and 1% standard deviation using a backward 250-days rolling window.

Our baseline results employ a sample starting in January 2006 and ending in December 2017. The starting year 2006 ensures that we observe an equity flow at every single day (as shown in Figure IA.1). Further details on the fund flow data and their coverage over time is provided in the Appendix.

Other data: Results for intraday asset price movements are based on futures on the S&P500 (symbol SP). For results on prices and quantities at the daily or longer horizons, we simply rely on the fund return $R_{i,t}$ for asset class i. Using fund returns ensures that the fund flow identity implied by Equation (2) is exactly satisfied and we capture the total change of investors' exposure to asset class i. We refer to the Appendix for further details.

3. Returns and fund flows on FOMC days

In this section, we first study how US equity prices and quantities (flows) respond to the revelation of monetary policy surprises on FOMC days. Subsequently, we study the persistence of these initial effects over several weeks. We then show that monetary policy induced risk shifts also affect other risky asset classes, such as corporate bonds, high yield bonds, and emerging market bonds and equities.

3.1. Initial response

Method: We run regressions of equity returns and flows on our monetary policy surprises on FOMC announcement days:

$$X_{t|FOMC} = a + b \times Monetary\ Policy\ Surprise_{j,t|FOMC} + \xi_{t|FOMC}. \quad (3)$$

Monetary policy surprises are measured intraday as outlined above. The baseline event window is 90 minutes and ranges from -15 minutes to +75 minutes for announcements without a press conference, and -15 minutes to the closing price (16:15) for announcements with a press conference. Equity returns are measured (i) intraday using futures on the S&P 500 and covering the identical event window as for the monetary policy surprises, or (ii) daily (close to close) using equity ETFs.[10] Equity fund flows are measured daily using the same ETFs as for the daily returns. Standard errors are based on a bootstrap that accounts for the fact that the regressors are estimated.[11] Table 2, Panel A, shows our baseline results.

Equity prices: We find that short rate and long rate surprises negatively affect stock prices, in line with common intuition (see Section 2). The t-statistics of the estimates indicate a relative low precision of the estimates. The regression R^2s are fairly low (below 10%). Changes in yields thus do not account for a lot of variation in equity excess returns on FOMC days. These results are in line with Bernanke and Kuttner (2005), Table II, which provides similar estimates (based on a different sample). The other side of the coin is that this result implies that the well-documented strong response of the equity market response to FOMC news must to a large

[10] We use all equity ETFs that belong to the Morningstar category Blend; see the Appendix for details.

[11] Following Swanson (2018), we first regress the individual risk-free and risky assets on our three monetary policy surprise measures. We then re-sample the residuals to generate 1,000 time series of the individual assets and re-do the factor analysis such that we obtain 1,000 re-sampled monetary policy factors. Afterwards, we run a bootstrap that draws from the re-sampled factors to compute standard errors that account for the fact that the explanatory variables are estimated.

extent be driven by economic forces not captured by changes in risk-free rates.

>>> TABLE 2 ABOUT HERE <<<

Contrary to the yield-based surprises, we find that a one standard deviation rise in our risk shift measure goes hand in hand with an intraday equity return of 0.70%, which is highly significant (t: 15.4). The large R^2 of 72% shows that FOMC risk shifts capture the bulk of the stock market response to the revelation of monetary policy news. Put differently, the same economic forces that move the financial instruments underlying our FOMC risk shift variable also lead to a strong equity price reaction. Point estimates for daily returns match with the intraday response (0.67%). The R^2 and t-statistics are lower, reflecting the fact that daily returns measure the response to monetary policy news with more noise (as also information unrelated to the monetary policy event gets impounded into prices when moving beyond a tight intraday event window). The effect of FOMC risk shifts is economically large. The annualized effect of a one-standard deviation surprise raises equity returns by 5.6% p.a. (=0.70%×8). This is of the same order of magnitude as historical estimates of the unconditional equity premium.

Comparison to non-FOMC days: A natural question is if the market reactions on FOMC days leading to risk shifts are special, or if we are simply picking up the negative correlation between stock returns and, e.g., changes in the VIX, which can be observed on non-FOMC days as well. To shed some light on this question, we next present results for a control group experiment in Panel B of Table 2. To this end, we first construct "pseudo" factors using all days in our sample based on an event window that ranges from 11:00 to 12:30. These factors use the same weights as in Table 1. The difference is that there is no systematic link to monetary policy news.

Our results based on the control group indicate that the asset price response on FOMC days is markedly different compared to days without systematic monetary policy news. For example, bond yields and equity returns are positively related on normal days, while equity returns co-vary much more with changes in long-term as opposed to short-term yields.[12] As expected,

[12] Also see Cieslak and Schrimpf (2018) who suggest that day-by-day comovement of stock returns and bond yields largely owes to fluctuations in risk-premia.

we find that equity returns respond positively to risk shifts in the control group as well. But, the reaction is much more muted, as indicated by a substantially smaller initial impact (point estimates of 0.25 vs 0.70) and a smaller R^2 (45% vs 72%). We thus conclude that the market reaction on FOMC days is indeed "special" and that such monetary policy induced risk shifts exert a much stronger initial impact compared to other days.

Equity fund flows: Turning to the reaction of quantities, we find that investors' portfolio reallocation decisions quite closely follow the price response of equities. A positive one unit standard deviation FOMC risk shift is associated with significant daily flows to equities of 0.33% (t: 2.8) on FOMC announcement days. The comparison to the control group shows that the equity fund flow reaction is much stronger on FOMC announcement days (point estimates of 0.09 vs 0.33). Finally, we find that a pick-up in short-term and long-term rates typically goes hand in hand with outflows from equities, in line with the reasoning that monetary policy tightening signals lower returns going forward. These initial reallocations are economically sizeable (about -0.20% and -0.25%) and confirm that monetary policy surprises lead to some significant portfolio rebalancing.

Discussion: Overall, we find a strong response of stock returns to risk shifts on FOMC days whereas the traditional yield-based measures of monetary policy surprises are relatively less important. We provide extensive robustness checks on this novel result later in the paper. Among other things, we show that (i) the weak result for monetary policy surprises constructed from yields is also present in an extended sample from 1998 to 2017. We also find that removing the ELB period (12/2008 to 12/2015) has little effect on the results for all three surprise measures and that risk shifts have been significant drivers of the stock market response already prior to the ELB period (see Figure 7 and Tables IA.5, IA.6, IA.7); (ii) our results are robust to using surprises measured from Fed funds futures instead of short and long-term bond yields (Table IA.8); and (iii) are mainly unaffected by sensible variations in the event window (Table IA.9).

3.2. Persistence of the initial response

Having established that there is a close link between equity prices, equity flows and risk shifts on FOMC days, which is different from non-FOMC days, we next turn to quantifying the effects of the three market-based monetary policy surprises over longer horizons. All left-hand side variables, flows and returns, are sampled daily (close-close) and are based on ETF fund data for consistency. The monetary policy surprises are measured intraday using a 90-minutes event window as before.

Method: To estimate the long-horizon reaction of asset prices and fund flows, we run local linear projections (Jorda (2005)) of fund returns and flows on monetary policy surprises:

$$X_{t \to t+h} = a_h + b_h \times Monetary\ Policy\ Surprise_{j,t} \times D_{FOMC,t} + \xi_{t+h}, \tag{4}$$

where $X_{t \to t+h}$ is the cumulative fund return, or flow, h is the horizon over which we cumulate the dependent variable (from $h = -1$ to $h = 20$ business days), $Monetary\ Policy\ Surprise_{j,t}$ is one of the three orthogonal monetary policy surprises (see Table 1 for details), and $D_{FOMC,t}$ is a dummy variable that takes the value of one at FOMC announcement days between 2006 to 2017. As above, standard errors are based on a bootstrap that accounts for the fact that the regressors are estimated (see Table 2 for details).

Since our goal is to estimate the *longer-term* response of asset prices and flows to monetary policy surprises here, we have to guard against potentially confounding information due to other monetary policy news released by the Fed (up to the horizon h). For this reason, we employ the database of important monetary policy events by Cieslak and Schrimpf (2018) to screen for other events that take place in the window from $h = +1$ to h=+20 business days after a particular announcement. As a result, we remove 18 confounding events from the event list.[13] See Table IA.4 in the Internet Appendix for details. This leaves us with 80 monetary policy decision events

[13] These are 13 FOMC events followed by unscheduled announcements of unconventional monetary policy, one unscheduled FOMC rate decision that is shortly followed by a scheduled announcement, and four FOMC events that are followed by influential speeches given by Chairman Bernanke (e.g., at Jackson Hole).

that allow us to estimate the longer term effects of our monetary policy surprises.[14]

Risk shifts: Figure 2 summarizes the reaction of equity prices and flows to a unit standard deviation increase of the FOMC risk shift variable. Reproducing our finding from above, an increase in the FOMC risk shift goes hand in hand with significantly higher daily equity excess returns of 0.70% (bootstrap t-statistic of 4.77) on FOMC days (close-close). However, as is also evident from Figure 2, the impact of the FOMC risk shift on stock prices is to a large extent transitory. After about one week, the initial increase in equity prices begins to melt away and is substantially reversed after about four weeks.

>>> FIGURE 2 ABOUT HERE <<<

Turning to the reaction of quantities (lower panel of Figure 2), we find that investors' portfolio reallocation decisions quite closely follow the price response discussed above (upper panel of Figure 2). More precisely, a positive one unit standard deviation FOMC risk shift leads to significant initial increase of 0.53% in standardized flows on FOMC announcement days. In the following couple of days, the shift to equities continues and cumulates to about 0.64% after five days. Afterwards, these reallocations are starting to reverse with ETF investors pulling out from equities, mirroring the pattern for prices.

Short and long rate surprises: Table 3 presents results for longer horizons for all three monetary policy surprises (see also Figure IA.4 in the Internet Appendix). In addition, the table shows results for bonds and the difference between equities and bonds, i.e., a measure of the equity premium. We find that a one standard deviation increase in short rates decreases equity prices by -0.38%. The effect is only marginal significant but persistent over horizons of up to four weeks. Turning to the fund flows, we find that the initially sizeable reallocations are are also transitory at a four-week horizon.

[14]Note that as a result we look at a slightly different set of FOMC announcements compared to the previous section (Table 2). For that reason, we do not expect to find the exactly identical results for daily returns and daily fund flows. The 18 confounding events cluster around the financial crisis; 17 confounding events fall into the period 12/2007 - 08/2011. As discussed in the robustness section, the Internet Appendix provides results when we ignore confounding events or when we remove the period of the financial crisis altogether.

A priori it seems likely that surprises to long-term rates should have become more prominent as drivers of stock prices during the period of the effective lower bound (ELB) and unconventional policies since 2009. Yet, this is not borne out in the data as we detect no statistically significant effects on stock returns.

>>> TABLE 3 ABOUT HERE <<<

3.3. Risk shifts in other asset classes

Our fund dataset allows us to study the impact of FOMC risk shifts on a broader set of asset classes, as shown in Table 4. The other risky asset classes are proxied by long-short strategies based on Morningstar categories and are long in the risky asset (e.g., high yield bonds) and short in the safe counterpart (e.g., broad US bonds). For the additional bond categories, the available sample is shorter and starts in 2010.

We find that FOMC risk shifts are accompanied by significantly higher returns in corporate bonds (+0.11%, t: 4.9), high yield bonds (+0.22%, t: 3.27), and emerging market bonds (+0.28%, t: 4.98) compared to US government and investment grade bonds ("broad" market bonds). Similarly, emerging market equities outperform US equities by 0.52% (t: 4.10).

Fund flows generally mirror the patterns in returns. Flows into the relatively riskier assets react positively to monetary policy induced risk shifts. Moreover, positive risk shifts go hand in hand with significant fund flows from safe to riskier assets at a weekly horizon. Overall, the results for other risky assets strongly corroborate our findings for US equities in the previous section. Thus, FOMC risk shifts do not just affect US equities but have a sizeable effect on risky asset classes more generally and on an international scale.

>>> TABLE 4 ABOUT HERE <<<

4. Understanding FOMC risk shifts

In this section, we aim to shed light on *why* we observe such strong price and flow movements around FOMC risk shifts as we have documented in the previous section. More specifically, we discuss three main channels: (i) monetary policy may lead investors to change their required risk premium (expected future excess return) and/or (ii) monetary policy might affect investors' expected future dividend growth. Finally, (iii) the strong but transitory movement in stock prices documented above could arise, at least in part, from price pressure driven by differential demands for risky assets on behalf of heterogeneous investors. In the following, we analyze the relative contributions of these channels as potential drivers of the patterns we see in the data.

4.1. VAR decomposition: Setup

Given the highly transitory nature of the price reaction on FOMC days (see Figure 2), it seems prima facie less likely that news about future dividend growth is the main driver as changes in such expectations should have persistent effects and not be reversed so quickly. Moreover, traditional long-horizon return predictors (e.g., the dividend-price ratio Campbell and Shiller (1988), or *cay* as considered in Lettau and Ludvigson (2001)) can be ruled out to bear a strong relation to the FOMC risk shift. These variables are known to capture variation in expected returns which is highly persistent, and their effect on equity prices have half-lifes of several quarters or even years.

Instead, recently proposed short-horizon equity premium predictors are prime candidates to test the idea that changes in risk premia might underlie FOMC risk shifts. Bollerslev, Tauchen, and Zhou (2009) show that the difference between option implied volatility and expected realized variance predicts future returns at the monthly and quarterly horizon, but not at the annual horizon. Martin (2017) derives an option-implied lower bound on the equity premium for horizons from one month up to one year and shows that this proxy of the expected equity premium forecasts returns over the short run (also see Martin and Wagner (2019)).

We use the standard VAR procedure put forth by Campbell and Shiller (1988) to decompose daily market excess returns (S&P 500 index returns minus the short-term risk-free rate) into discount rate news and a residual. We consider a VAR model specifications that includes the lower bound on the equity premium (i.e., the SVIX-based measure of the equity premium Martin (2017), the variance risk premium (Bollerslev, Tauchen, and Zhou (2009)) and the dividend-price ratio (Engsted, Pedersen, and Tanggaard (2012)).[15] We refer to Appendix B for details on the implementation.

4.2. VAR decomposition: Risk premia

Drawing on the VAR decomposition above, Figure 3 illustrates which return components respond the most to the revelation of FOMC news. The black line depicts the reaction of the total return (as before), and the blue line represents the component that can be attributed to changes in risk premia as measured via the VAR. Thus, the difference between the black line and the colored line can be interpreted as the residual return component.

>>> FIGURE 3 ABOUT HERE <<<

We find that (short-term) fluctuations in risk premia play a prominent role on FOMC days, explaining about 44% of the immediate market reaction. In other words, a large share of the price action in equities can be attributed to changes in risk premia induced by monetary policy news.[16] That said, the reaction of stock returns to monetary policy is stronger than what can be justified by changes in risk premia alone. About 56% (the difference between the black line and the blue line) are highly transitory and almost disappear after about one week. This finding speaks against the idea that the residual can be explained by dividend growth news as suggested by the present value decomposition as one would expect expectations about fundamentals to exhibit a more persistent impact. Yet, this finding squares well with the notion that "price pressure" effects amplify risk premium changes on FOMC days. We turn to the role of price pressures next.

[15] We only have Ian Martin's SVIX data up to 08/2014, and therefore the analysis in this section is for a shorter sample period (69 FOMC announcements, 53 non-confounding).

[16] Since the VAR relies on a particular set of short-term return predictors, we also consider an (almost) model free specification by just looking at the change in Martin (2017)'s SVIX-based measure of the equity premium at the one year horizon in Figure 3. This is a conservative estimate because it ignores changes in expectations from the one-year horizon onwards. However, this proxy of the equity risk premium cannot suffer from overfitting or sample selection issues, as the relationship with expected returns does not need to be estimated. We find that using the SVIX corroborates the VAR-based conclusion that FOMC risk shifts relate – at least in part – to changes in risk premia.

4.3. Price pressure

Intraday ETF prices and volume. A natural explanation for why we find that risk shifts are accompanied by large but transitory price changes around FOMC days is price pressure due to investor rebalancing, which acts as an amplifier in the short run. To evaluate this possibility, we first document the intraday pattern of ETF prices and volumes around FOMC risk shifts in Figure 4.

>>> FIGURE 4 ABOUT HERE <<<

The left-hand side of Figure 4 shows the intraday response of the largest US equity ETF, the SPDR S&P 500 ETF.[17] In this figure, we distinguish depending on the sign of risk shifts (positive: risk on events, negative: risk off events) but also show the response across all events taken together. These results confirm that FOMC risk shifts lead to a large response in equity prices with the release of FOMC statements.

Figure 4 further shows that FOMC announcement are highly news-intensive and trigger an unusually large trading volume as the information gets embedded into prices via the trading process. On the right hand side, the figure reports ETF volume divided by the average ETF volume in the first two trading hours of the respective day. Trading volume increases substantially with the release of the FOMC statement, on average by a factor of 4.5. The increase is substantially higher for events with high absolute FOMC risk shifts (by a factor of 6.5) compared to events with a low absolute risk shift (3.7).[18] Put differently, trading is 70% (6.5/3.7-1) larger for FOMC events where we observe a large sized risk shift. This finding confirms that the elevated equity flows measured at the daily horizon are directly linked to the announcement of FOMC statements.[19]

Overall, our findings suggest that there must be a subset of (active) investors which is

[17]This analysis is based on an extended sample period, which is discussed in detail in Section 5.1.1.

[18]Trading volume is non-directional and hence we use absolute values of risk shifts in this exercise.

[19]This volume reaction suggests a role for heterogeneous investors in driving the stock market response to scheduled FOMC meetings. For example, Bogousslavsky (2017) shows that infrequent rebalancing by some investors can generate substantial seasonality in asset returns. Such a channel has not yet been considered to theoretically explain the stock market around FOMC announcements and provides an interesting avenue for future research.

particularly sensitive to FOMC risk shifts, in turn expressing their views on monetary policy and the stock market via ETFs. These seemingly more active investors react with economically large reallocations to equities as well as other risky assets.

Big vs small ETFs. We next present evidence on which kind of investors are the driving force behind large fund flows observed around FOMC risk shifts. ETFs allow investors to obtain quick exposure to a particular asset class. The literature suggests that institutional investors make particular use of ETFs for short-term tactical asset allocation decisions (e.g., Ben-David, Franzoni, and Moussawi, 2018; Balchunas, 2016; Lettau and Madhavan, 2018, among others). It seems reasonable to assume that the group of active market participants that uses ETFs to alter their positions belongs to the broader group of institutional investors. Since such investors will prefer bigger and more liquid ETFs over smaller and less liquid ones to implement their tactical trades, we would expect to see a significant difference in flows between large and small ETFs on FOMC days. Finding such an effect would lend some credence to the view that price pressure is an important part of the observed stock return reaction on FOMC days.

To test this, we sort all ETFs that invest in US blend equity into two portfolios according to their total net assets. The first portfolio contains the 50% funds with the largest total net assets (BIG) and the second portfolio contains the 50% fund with the smallest total net assets (SMALL). We then form flow and return factors of "BIG" funds minus "SMALL" funds. Importantly, our big and small funds invest in the underlying stocks, their return correlation is 0.98. And, they have almost the same average returns (9.8% p.a. vs 9.6% p.a.). They only differ in their total net assets, i.e., the availability of fund shares on the market, and their liquidity.

>>> FIGURE 5 ABOUT HERE <<<

Figure 5 shows that big funds outperform small funds for positive FOMC risk shifts, i.e. big funds' share prices are pushed up more strongly than small funds' share prices. However, this effect is largely reversed over the following days (upper panel of Figure 5). Confirming the pattern in prices, the lower panel shows that a positive risk shift leads to significantly more flows into big funds than into small funds. We interpret the spike in the price of big funds on days with large FOMC risk shifts as a liquidity fee for providing timely exposure to the stock market.

Fund flow-induced price pressure: Finally, we estimate the amount of price pressure that is *directly* triggered by flows to better understand the stock market response to FOMC news. To do so, we employ a regression-based method inspired by Hendershott and Menkveld (2014) where we measure the price pressure component in stock returns driven by flows. We provide a detailed explanation of this approach in the Appendix C.

Obviously, for significant fund flows to occur around FOMC announcements there must be one subset of investors that is raising its exposure to the equity market, while another group needs to be induced to absorb these flows. Such reallocations in turn consume liquidity and, thus, ultimately give rise to transitory "price pressures" that amplify the stock market response to monetary policy news.[20]

Following this reasoning, we propose a parsimonious return decomposition based on a regression of daily S&P 500 excess returns on daily contemporaneous and lagged equity (ETF) flows:[21]

$$\begin{aligned} R_t^e &= constant + 0.27F_t + 0.00F_{t-1} - 0.01F_{t-5:t-2} - 0.01F_{t-20:t-6} \\ &\quad + (0.13F_t + 0.22F_{t-1} + 0.05F_{t-5:t-2} - 0.04F_{t-20:t-6}) \times D_{FOMC,t} + \iota_t \end{aligned} \tag{5}$$

The "information component" of S&P 500 excess returns is measured as the constant and the unexplained part: $R_{M,t}^e = constant + \iota_t$. The "flow-induced price pressure component" is the part explained by fund flows: $R_{S,t}^e = R_t^e - constant - \iota_t$. The identifying assumption of this approach is that fund flows do not contain fundamental information already reflected in prices.[22]

>>> FIGURE 6 ABOUT HERE <<<

[20]An alternative story, in which these short-term fund flows contain information about future fundamentals seems hard to believe and, in fact, we do not find that flows positively forecast future equity returns.

[21]Our regression specification is inspired by popular long-memory models of expected volatility, e.g., Corsi (2009).

[22]For further discussion, see Appendix C and Table 6.

Figure 6 shows how the total return (black), the transitory flow-induced price pressure component (red) and the unexplained component (which we label "permanent component", blue) respond to risk shifts around FOMC events. We find that it is indeed the flow-induced price pressure component that captures most of the transitory component. A sizeable part of the initial stock return reaction – about 40% (0.27/0.70) – can be explained by price pressures.

4.4. Changes in beliefs and risk sentiment

Finally, we investigate the link between risk shifts and changes in investor beliefs to better understand why we observe risk shifts coupled with strong price pressure and high trading volume. We do so by examining the sentiment in news articles around FOMC days (assuming that changes in news sentiment reflect actual changes in investor beliefs). Our rationale for this approach is the following: If positive risk shifts indeed reflect that more active investors seek greater exposure to risk, by entering into a "risk on" mode, we should observe that news sentiment around such FOMC days becomes more positive. Moreover, the large trading volume around FOMC days suggests sizeable heterogeneity in beliefs between different investors groups, which leads to a strong portfolio rebalancing once the more active traders trade towards their desired portfolio allocations (e.g., Scholes (1972); Glosten and Milgrom (1985); Grossman and Miller (1988); or Hendershott and Menkveld (2014) for a recent paper).

News-based sentiment: To test whether risk shifts are indeed related to a change in beliefs of (at least some) market participants, we measure sentiment as the average event sentiment score (ESS) of all articles in the Ravenpack News Analytics database related to "United States Federal Reserve" and "Board of Governors of the Federal Reserve System" in the x days before an FOMC meeting and separately for the x days after an FOMC meeting (we let x vary from 3,5,7,10,...14 days). We then compute the change in sentiment as the change in the average of relevance-weighted sentiment scores across the pre- and post-FOMC windows.[23] We then regress these sentiment changes on the three types of monetary policy surprises in univariate

[23] Ravenpack ESS scores are a standard way of proxying for the sentiment of news articles. See, e.g., Asness, Liew, Pedersen, and Thapar (2019) for another paper that also relies on these sentiment scores (in a different context).

and multivariate specifications.

The results are reported in Table 5. We find that news sentiment improves following positive FOMC risk shifts. Results for the yield-based factors are mixed. Long rate surprises that lead to a tightening tend to depress sentiment which is in line with the idea that monetary policy surprises inferred from long rates are potential proxies for market confidence (Boyarchenko, Haddad, and Plosser (2017)). However, we do not find that short rate surprises have a meaningful relation to the tone of news articles.

>>> TABLE 5 ABOUT HERE <<<

Overall, we find that positive risk shifts, which we interpret as a greater desire by more active market participants to take on risk (akin to a "risk on" mode), is indeed accompanied by a more positive news flow around FOMC meetings. While investor beliefs are not directly observable, this positive correlation of news sentiment and our measure of market-based risk shifts lends some credence to the view that we are indeed capturing a shift in active investors' risk perceptions that are triggered by news about monetary policy. Interestingly, we find that long-rate surprises, which are orthogonal to risk shifts by construction, also affect news sentiment which underscores our result that there are different, but complementary, components in monetary policy surprises.

Textual analysis of market commentary: To examine the news content *on* FOMC days in more depth, we turn to an analysis of market participants' own interpretation of monetary policy events. We collect market commentaries on the FOMC meeting from *Thomson Reuters Instant View* (TRIV). TRIV collects and publishes views and commentary from market experts (e.g., traders, analysts, economists) on the outcome of the meeting shortly after an FOMC announcement (i.e., on the same day in the late afternoon). We always pick the complete TRIV column for each of our 96 scheduled FOMC events and do not select particular analysts or firms.

We then count the frequency of words that relates to economic and financial conditions or the surprise content of the news divided by the total number of words. Finally, we regress the absolute FOMC risk shift on the relative frequency of these words for the 96 scheduled FOMC meetings in our sample.

Economic conditions (inflation, employment, growth) do not explain a large share of the size of FOMC risk shift (Table IA.11 in the Internet Appendix). Instead, we find that the phrases capturing changes in investors' risk sentiment or beliefs more generally such as "surprise", "confidence", and "disagreement" are indeed closely related to FOMC risk shifts. Together, they explain up to 31% of absolute FOMC risk shifts.[24] These results confirm that risk shifts are associated with changes in market participants' risk perceptions and that disagreement between different groups of investors seems to play a role in generating large risk shifts. This finding squares will the one above that risk shifts are accompanied by large trading volume and ETF fund flows.

Narrative market commentary: Finally, we complement the above results on news sentiment with a qualitative approach. In this context, we closely read through the market commentary around FOMC days with large risk shifts. Our source of information is again TRIV. We document examples of the type of commentary in Tables IA.14 and IA.15 in the Internet Appendix and only summarize some key take-aways from this exercise here.

A prime example of a risk shift event is the announcement of the Fed's third large-scale asset purchase program (QE3). It comes with one of the largest positive FOMC risk shifts in our sample. A representative quote taken from the markets commentary characterizes the policy action as "exactly what Wall Street and, quite frankly, Main Street wanted from the Fed" (Tables IA.14). Another instructive example is the "taper tantrum" in 2013, which is associated with one of the most negative FOMC risk shifts in our sample. Analysts were taken by surprise by the announcement and summarized that "investors always freak out at what looks like a sea change in policy" (Tables IA.14).

A final example comes from the two meetings in early 2015, when the Fed decided to keep the policy rate low for the moment but left the possibility of later rates hikes open (Table IA.15). At the January FOMC meeting, this was a surprise to markets, as "everybody [had] baked into the

[24]The Internet Appendix also provides the corresponding results for short rate surprises (Table IA.12 and Table IA.13). We find that both yield-based factors relate to market commentary about "employment". Long rate surprises, in addition, correlate with commentary about"growth" and "confidence".

cake at least one interest rate hike". In the following FOMC meeting in March, the statement removed ambiguity from the statement and Wall street "applaud[ed] the Fed's action today".

To sum up, the qualitative analysis of market commentary corroborates our interpretation above, i.e., that risk shifts seem to be related to surprises about the stance of monetary policy. Whenever the Fed deviates from the prior by active market participants, we tend to observe negative risk shifts akin to a "risk off" mode (drop in stock returns, a higher VIX, higher CDS spreads and a stronger dollar). By contrast, when the Fed delivers a policy action confirming the prior views of active market participants, we observe a positive risk shift and active market participants enter into a "risk on" mode.

5. Robustness and further results

5.1. Robustness

5.1. Extended sample period, 1998-2017

How does the impact of our three monetary policy surprise measures, in particular that of risk shifts, evolve over time? To address this question, we first re-run our monetary policy factor analysis using an extend sample of 165 FOMC announcements from 1998 to 2017. We rely on the same set of risk-free interest rates as in the baseline results. However, due to data limitations, we include the VIX as the only risk asset.[25] Second, we conduct a sub-sample analysis by joining the extended sample period data with that from our baseline specification. These results are summarized in Figure 7.[26]

>>> FIGURE 7 ABOUT HERE <<<

The upper left figure shows the R^2 of a regression of intraday equity returns on our three monetary policy surprises for 165 FOMC announcements from 1998 to 2017, as well as for 108 FOMC announcements that exclude the period where the effective lower bound (ELB) might affect our results (12/2008 to 12/2015). The extended sample results are qualitatively fairly

[25] Table IA.5 in the Internet Appendix provide the results of the extended factor analysis.

[26] Tabulated results can be found in the Internet Appendix, Table IA.6.

similar to our baseline results (2006 - 2017). Risk shifts explain most of the variation of stock returns around FOMC announcements (47%), followed by short rate and long rate surprises (at 12% and 0% respectively). Removing the period containing the effective lower bound (12/2008 to 12/2015) has little effect on the R^2s of the three surprise measures.

The remaining sub-figures show results from rolling regressions using the past 40 FOMC announcements (i.e. effectively a 5-year rolling window). Vertical lines indicate the full sample results and the results when we exclude the ELB for the ease of comparison. We find that short rate surprises played a more important role before the end of 2005, compared to the later periods, as indicated by R^2s as large as 30%. After 2005, i.e. well before conventional monetary policy was constrained by the effective lower bound, short rates tend to lose in importance as indicated by a fall in R^2s. Regarding long-rate surprises, the subsample analysis confirms that long rate surprises are no important driver of the stock market in any subperiod that we study. This is surprising as one would have suspected a larger role of long-term rates that could at least partly compensate for the declining effect of short rate surprises in the ELB period.[27]

Our weak results for short rate surprises are also not driven by our measure of (short-rate) rate surprises. The sub-figure for short rate surprises adds results based on changes in Fed funds futures as reported in Gorodnichenko and Weber (2016).[28] We find that the latter only explain marginally more variation of stock returns (FFR:20% vs SR:14%) in the sample period before the effective lower bound.[29]

Finally, the sub-sample analysis provides several interesting insights regarding the role of risk shifts. We find that before 2005, risk shifts explained between 20% up to 30% of the variation of stock returns on FOMC announcement days. This is similar to the fraction of the FOMC stock market response explained by short rate surprises during this period. However, the explanatory

[27] First, Swanson and Williams (2014) show that long rates remained responsive to macro news and hence were not constrained by the ELB. Second, certain monetary policies during the ELB, such as quantitative easing and forward guidance, were designed to operate via long rates.

[28] We collect the changes in futures of Fed funds rates and the stock market return directly from the replication data files available to their paper, i.e. these are the same data as studied in their paper.

[29] Detailed results can be found in Table IA.7 and Table IA.8. Interestingly, we find that changes in Fed funds futures have only a high explanatory power before the end of 2005. The regression R^2s when using Fed funds futures collapses to 1% in the sample 2006-2009 (in line with Gorodnichenko and Weber (2016), Table 3). In comparison, the three-month rates (or our short rate factor) produce more stable results across subsamples.

power of risk shifts increases gradually starting in 2005 and reaches up to 80% in the subsamples just *before* short rates hit the effective lower bound. Post 12/2008, we find that R^2s actually drop a bit and only come back to 80% towards the end of the sample.

To sum up, we find that risk shifts played a prominent role even in the earliest possible sub-sample that we can study. We find that post-2005 the importance of risk shifts picks up, well before the financial crisis and the period when rates hit the ELB.

5.1. *Leave one out* FOMC risk shifts

We study the robustness of our risk shift measure via a "leave out" analysis. To see whether one specific risky asset (the VIX, CDX, or DOL) is crucial for the construction of the risk shift factor, we drop one after another of three variables, re-run the factor analysis, and then re-estimate the effect of risk shifts on asset markets. Figure 8 shows that the results are virtually unchanged to the baseline results. In essence, this analysis shows that two of the risky asset prices span the information content of all three variables.

>>> FIGURE 8 ABOUT HERE <<<

5.1. *Tighter or wider event windows*

In event studies of the style we conduct in this paper it is of interest to investigate the sensitivity of the result to sensible variations in the event window. Table IA.9, in the Internet Appendix, reports how results change for a tighter or wider event window. The wide event window (Panel A) starts 15 minutes before each announcement but always ends at the close. The tight event window (Panel B) starts 15 minutes before each announcement but always ends 45 minutes afterwards, also on announcement days that include a press conference. We generally find that estimates are quite similar to the baseline specification. The R^2s of daily returns and flows tend to increase in case of the longer window, which makes sense as the event window in this case has a larger overlap with the daily returns. The R^2s of daily returns and flows tend to decrease as we use a tighter window, which makes sense as the event window has now a smaller overlap with the daily returns.

5.1. Does the financial crisis drive our results?

Our baseline results already exclude events that might be confounded by additional announcement of monetary policy news within the event window. In the Internet Appendix (Figure IA.5), we show results when the financial crisis period is removed from the event list, i.e., all FOMC announcements that fall into the period from 08/2007 - 12/2009 are excluded. We find that the main conclusions from our baseline results are unchanged.[30]

5.1. Are events with a press conference different?

The recent literature has shown that press conferences carry important information for investors (e.g., Boguth, Gregoire, and Martineau (forthcoming)). Thus, it is interesting to ask whether results are different for FOMC announcements that are not followed by a press conference. To level the playing field between events with and without a press conference, in this exercise, we extend the event window for events without a press conference to the closing price of the announcement day, i.e., the event windows are the same for both types of events.

In the Internet Appendix (Figure IA.6), we show that restricting the sample to the 53 FOMC announcements without a subsequent press conference leads to point estimates for return and flow responses similar to those for the baseline case. However, we find that long-horizon confidence intervals tend to be larger when press conferences are excluded.[31] On the other hand, restricting the sample to the 27 FOMC announcements with a subsequent press conference leads to tighter confidence intervals. Overall, our results seem to depend very little on the in- or exclusion of press conferences.

[30]Moreover, as discussed above, we carefully account for the effects of potentially confounding events when gauging the longer-horizon effects of our monetary policy surprises. In the Internet Appendix, we provide results for the full sample and when *including* the confounding events (Figure IA.7). We find similar point estimates, but confidence bands are wider compared to the baseline results, or when we simply exclude the financial crisis.

[31]Using the narrow -15m:+75m event window for events without a press conference leads also to similar point estimates but even wider confidence bands.

5.1. Evidence from macroeconomic news announcements

Are FOMC announcements special? In the Internet Appendix (Figure IA.9), we analyse the response of equity prices and flows to risk shifts on days when important macroeconomic news (i.e. nonfarm payrolls, the producer price index, or the consumer survey report) are released. To avoid events that overlap with FOMC announcements, we exclude macro announcement in the vicinity of FOMC events in this analysis, i.e. observations 5 days prior and up to 10 days after FOMC announcement days (FOMC period).

We find some notable difference between macroeconomic data releases and FOMC events. The equity price response to a risk shift generated by macro news even tends to be somewhat stronger in the short-term (+0.80%). Importantly, the overall effect on prices (after 20 trading days) has a large persistent component, though. The reaction of flows to macro news is also fairly weak, in stark contrast to their typical response to FOMC risk shifts.

In sum, macro news move prices permanently and do not impact flows as much as FOMC announcements do. This finding suggests that macro news reveal news about fundamentals, leading investors to update their expectations for example about dividend growth (which causes a permanent change in prices). By contrast, FOMC announcements trigger abnormal fund flows and lead to a largely transitory change in stock prices which are more challenging to explain.

5.1. Regression-based FOMC risk shifts

To see how our factor analysis to extract monetary policy surprises might affect the main results, we consider an alternative, more simple, risk shift measure in Figure IA.8 of the Internet Appendix. The alternative risk shift factor is the simple average of the three (standardized) risky asset price changes, orthogonalized with respect to the four yield changes using linear regressions. We find very similar results: large initial price and flow reactions that show a large transitory component.

5.2. Further results

We provide further results in the Internet Appendix, which are summarized below.

Longer horizon response in the extended sample (1998-2017): Figure IA.10 provides the long horizon response of equity prices and flows for the extended sample period from 1998-2017 as well as the sub sample 1998-2005. The downside of the longer sample is that we need to rely on less detailed and less reliable data for this exercise.[32] Yet, the reaction of stock returns is overall very similar to the results documented above for the more recent sample period. Prices revert back to a large extent within four weeks. The point estimates of the response of fund flows is more muted in the early sample period (1998-2005).

Mutual funds vs ETFs: It is interesting to compare the reactions of ETF investors to those in mutual funds. We label mutual fund flows as "slow money" since they are typically subject to front-end fees and thus are not well suited for gaining short-term exposure to an asset class. Furthermore, retail clients account for a sizeable share of mutual fund volume, and retail investors are typically less responsive to news Frazzini and Lamont (2008). Based on this reasoning, we expect that mutual fund flows are not subject to (large) FOMC risk shifts.

Consistent with this prior, we find that mutual fund flows do not respond in a meaningful way to FOMC risk shifts. Figure IA.11 in the Internet Appendix provides the results. In fact, flows remain flat within the event window. However, mutual fund returns follow the overall market, as one might expect.

Outlier Analysis: Influential observations can affect the results in a material way in event studies of the type we run in this paper. To guard against that possibility, Figures IA.12 - IA.14 of the Internet Appendix show the effect of the three monetary policy surprises on returns and flows when we drop one single observation at a time from the sample. We find that results on risk shifts are unaffected, as might be expected, given the tight confidence bands.

[32] We extend the sample period back to 1998 by focusing on returns and flows of the SPDR S&P 500 ETF (ticker: SPY) from State Street Global Advisors. The SPY was the first ETF introduced in 1993 and is until today the largest US equity ETF. We count almost no zero flows after 2006 for the SPY (less than 5%). However, around one half of the flow observations are zero in the earlier sample from 1996 to 2005, which indicates less frequent ETF trading in this sub-sample. There are no bond ETF funds available for the complete 1996 - 2005 sample period and for that reason we focus on equity markets only.

6. Conclusion

US monetary policy announcements are special events for financial markets. They are one of the most anticipated news events watched by market participants and frequently generate large movements in stock prices. Yet, surprise movements in risk-free rates, the focus of most of the earlier literature, are able to explain only a small fraction of up to 20% of these stock price movements.

We argue that this result should not be overly surprising because it is well known that changes in risk-free rates do not span equity risk premia and that monetary policy does not only affect risk-free interest rates. It is thus important to go beyond risk-free yields to capture the various dimensions of monetary policy surprises. We suggest to include risky assets (such as the VIX, CDS premia and the US dollar) in an otherwise standard factor analysis that also includes a cross-section of short and long-term risk-free rates to extract monetary policy surprises from high-frequency market prices. The first two measures of monetary policy surprises we extract capture short and long term interest rate surprises (as in the earlier literature). Our third surprise measure, which we label “FOMC risk shifts”, is new and captures the response of risk premia that is orthogonal to changes in interest rates. A new angle of our work is to go beyond the pure response of prices and to also study how quantities, in particular fund flows by ETF investors, change around FOMC events.

We find, first, that FOMC risk shifts emerge as a much more powerful driver of stock market returns around FOMC days than conventional interest rate surprises. They robustly capture about 70% of the variation in stock returns, measured intraday over a tight event window around FOMC announcements. This finding holds true even before the effective lower bound. And we find the link between risk shifts and returns to be significantly stronger on FOMC than on non-FOMC days. Second, FOMC risk shifts are a major driver of portfolio reallocations as measured via ETF flows. Third, these effects do not only hold for US equities but extend to other risky asset classes as well, in particular corporate credit an emerging market assets.

We run a host of tests to better understand the economic mechanisms at play. Based on

VAR decompositions, we find that short-term fluctuations in risk premia are able to explain less than half of the overall effect. The remaining share is largely driven by flow-induced, transitory price pressure, which is quickly reversed after the FOMC meeting.

Finally, we ask *why* monetary policy news would induce changes in risk perceptions and lead to portfolio rebalancing, which alters investors' exposures to risky assets? To provide intuition about some possible mechanisms, we rely on an analysis of news article sentiment and textual analysis of market commentary around FOMC days. Our results suggest that risk shifts are related to changes in the sentiment of market participants and, more specifically, that risk shifts tend to be larger when market participants disagree more about the stance of monetary policy. A plausible interpretation of these results is that asset prices and flows around FOMC announcements are driven by the interactions of different sets of investors, which differ in their rebalancing frequencies and investment horizons. Some market participants rebalance their portfolios frequently and may adjust their positioning based on monetary policy news. Other players, by contrast, play a more passive role and absorb such flows (e.g., market makers who provide immediacy but also longer-term investors who need to be incentivized to take the other side). Our results suggest that in particular monetary policy news that does not conform with the priors of active market participants leads a drop in their willingness to take risks, a reduction in sentiment and a rebalancing away from risky assets. Such negative risk shifts ("risk-off") go hand in hand with a surge in trading volume and contemporaneous price pressure to induce the passive investors to absorb these flows, which is subsequently reverted.

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Appendix

A. Details on data and variables construction

High frequency data: The sources of the high-frequency data are Tickdata.com, Thomson Reuters TickHistory, Kibot.com, and CMA (Credit Market Analysis Ltd.) Datavision. Treasury bond futures of a given maturity refer to a hypothetical bond with a coupon of 6%. We back out the future implied yield and assume that the maturity of the cheapest to deliver bond matches with the face maturity of the future. There are no CDX futures available. Intraday data on the CDX index is sourced from CMA Datavision who collects information on executable and indicative CDS quotes directly from dealers in credit markets. We use VIX data from Tickdata.com for the period 2006 to 2017, and from Kibot.com for the period 1998 to 2005.

Fund flows: We collect daily ETF (and mutual fund) data from Trimtabs.[33] The dataset covers (almost) all ETFs traded in the US, about 2 trillion USD total net assets at the end of 2015 (and about 1.6 trillion USD in total net assets for mutual funds). From 2010 onwards, the database covers all ETFs. Before 2010, a few ETFs seem to be missing (in particular newly introduced ETFs). With respect to mutual funds, Trimtabs conduct their own survey to obtain fund flows and returns for approximately 15% of the market.[34]

We aggregate individual funds to asset classes. Our measure for US equity is based on all funds that belonging to Morningstar's category "Blend".[35] Our measure for US bonds is based on all funds that belong to the Morningstar categories US "government", or investment grade "bond".[36]

Fund flows at the asset class level are measured as:

$$F_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1}\left(1 + R_{i,t}\right)}{TNA_{i,t-1}},$$

where $TNA_{i,t}$ are total net assets of asset class i (equity or bond) at time t, and $R_{i,t}$ is the fund return of asset class i. Because fund flows do not have an economically meaningful long-run mean or standard deviation, we follow the recent literature (e.g., Berk and van Binsbergen (2016), Menkhoff, Sarno, Schmeling, and Schrimpf (2016)) and use a normalization. In particular, we normalize flows by their moving average and standard deviation:

$$\tilde{F}_{i,t} = \frac{F_{i,t} - \mu_{i,t}\left(F_{i,t-250;t-1}\right)}{\sigma_{i,t}\left(F_{i,t-250;t-1}\right)},$$

where $\mu_{i,t}\left(F_{i,t-250;t-1}\right)$ and $\sigma_{i,t}\left(F_{i,t-250;t-1}\right)$ are computed over lagged 250-day rolling days. If there is a zero flow, we ignore this observation when computing the rolling mean or standard deviation and we also do not adjust any zero flow observation in the sample. Following Staer (2017), we move

[33] http://trimtabs.com/data/fund-flows.html.

[34] The Investment Company Institute estimates the mutual fund market - all equity and bond funds - to about 12 trillion USD at the end of 2015, see http://www.ici.org/research/stats/trends.

[35] Morningstar categorizes all US funds into nine categorizes along the dimension value, blend, growth, and large, mid, small. We aggregate the categories blend-large, blend-mid, and blend-small to blend.

[36] The Morningstar categories we rely on are given as follows: short government, intermediate government, long government, short-term bond, intermediate-term bond, and long-term bond. The latter three categories invest only in investment-grade bonds and target the "broad" market.

reported flows one day forward to account for the lag between fund share creation and reporting.[37]

Equity ETF data start in 1993, and bond ETF data start in 2002. However, the total ETF assets under management are low in the earlier years and the time-series are notoriously plagued with zero flow observations, indicating low activity. To have some numbers, total assets under management in ETFs are 1.7 billion in 1997 (the first year they cross 1 billion), about 250 billion in 2006, and more than 2,000 billion in 2015. Figure IA.1 provides an overview of total net assets of ETFs over time, as well as % of daily zero flow observations. The cut-off year 2006 for our baseline results (3,019 daily observations; 98 FOMC announcements) ensures that we almost always observe non-zero flows for "Blend" equity and "Broad" bond funds.

ETF and mutual fund flows are to our knowledge the only investor flow data available at the daily frequency, and are available for a fairly long time period. In our empirical analysis, we mainly focus on ETF fund flows as these flows are more likely to represent "fast money". Transaction costs are low for ETFs (there are no front-end loads). They allow investors to quickly build up, or reduce, positions in one asset class or another. This point is also made in Ben-David, Franzoni, and Moussawi (2017) and Lettau and Madhavan (2018), among others. For that reason, ETFs are frequently used by institutional investors to obtain tactical exposure to certain asset classes, in particular at short horizons.[38]

In the Internet Appendix to the paper, we also compare results from ETFs with mutual funds. We refer to mutual funds as "slow money", because of their fairly high transaction costs (front-end fees, but also buying/selling restrictions for large block investors). Mutual fund flows are thus likely to be less responsive to news (e.g., Barber, Odean, and Zheng, 2005; Frazzini and Lamont, 2008).

B. Details on the return decomposition

Campbell and Shiller (1988) and Campbell (1991) show that unexpected realized returns are equal to revisions in future expected dividends minus revisions in future expected returns:

$$r_{t+1} - E_t\left[r_{t+1}\right] = \eta_{d,t+1} - \eta_{r,t+1},$$

where $\eta_{d,t+1} = E_{t+1}\left[\sum_{j=0}^{\infty} \rho^j d_{t+1+j}\right] - E_t\left[\sum_{j=0}^{\infty} \rho^j d_{t+1+j}\right]$ summarizes "cash-flow news", and $\eta_{r,t+1} = E_{t+1}\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right] - E_t\left[\sum_{j=1}^{\infty} \rho^j r_{t+1+j}\right]$ summarizes "discount rate news".

To decompose stock returns, we follow a large literature (including Campbell and Shiller (1988)) and use a VAR of the form $\boldsymbol{z}_{t+1} = \boldsymbol{A}\boldsymbol{z}_t + \boldsymbol{\varepsilon}_{t+1}$, with $\boldsymbol{z}_t = [Ret_t - Rf_t,\ \boldsymbol{x}_t]'$. The first element of $\boldsymbol{z}_t$ is the excess return of the S&P 500 index ($Ret_t - Rf_t$) and the following elements contain the up to three return predictors ($\boldsymbol{x}_t$). The VAR coefficient estimates for the model with three predictors can be

[37] ETF flows are triggered when authorized participants buy the stocks underlying the ETF portfolio and exchange these with the fund against new ETF shares. However, the clearing takes place after markets close and before they re-open. New shares then typically show up the next day (or even later) in the funds balance sheet, when the trade was approved by the counterparties. Thus, moving reported ETF flows one day forward better matches with when the underlying stocks were actually bought, or sold, in the market. For further details about the creation and redemption process, see the excellent reviews by Ben-David, Franzoni, and Moussawi (2017) and Lettau and Madhavan (2018), or for even more details on the timing, "Understanding Exchange-Traded Funds: How ETFs Work", by the Investment Company Institute available at https://www.ici.org.

[38] Balchunas (2016) and Madhavan (2016) argue that ETFs are popular among institutional investors for (short-term) tactical asset allocation decisions. Madhavan (2016) reports that ETFs have high institutional ownership (about 65%) and a much higher annual turnover (more than 20 times assets under management) compared to comparable passive mutual funds (less than 20%). Based on 13-F institutional holdings data, Ben-David, Franzoni, and Moussawi (2018) provide direct empirical evidence for institutional investors using ETFs for tactical asset allocation decisions.

inspected in Table IA.10.

Defining a vector where the first element is one and all other elements are zero (e.g., $\mathbf{e1}' = [1, 0, 0, 0]'$) we can measure discount rate news as:

$$\eta_{r,t+1} = \mathbf{e1}' \sum_{j=1}^{\infty} \rho^j \boldsymbol{A}^j \boldsymbol{\varepsilon}_{t+1} = \mathbf{e1}' \rho \boldsymbol{A} \left(I - \rho \boldsymbol{A}\right)^{-1} \boldsymbol{\varepsilon}_{t+1}.$$

According to the VAR, the unexpected excess return is equal to $(Ret_{t+1} - Rf_{t+1}) - E_t\left[Ret_{t+1} - Rf_{t+1}\right] = \mathbf{e1}'\boldsymbol{\varepsilon}_{t+1}$. Because unexpected excess returns are the difference between revisions in expected future dividends ($\eta_{d,t+1}$) and discount rate news ($\eta_{r,t+1}$), it is possible to back out cash-flow news as $\eta_{d,t+1} = \mathbf{e1}'\boldsymbol{\varepsilon}_{t+1} + \eta_{r,t+1}$. This definition assumes that the predictor variables in the VAR indeed capture all available information about future returns, i.e. any missing information will go into the residual.

The return component that can be attributed to discount rate news is $-\eta_{r,t+1}$, and hence we run the linear projections:

$$-\eta_{r,t+1} = a + b_h \times MP\ Surprise_{j,t} \times D_{FOMC,t} + \xi_{t+h},$$

and plot these in Figure 5. We compare results to linear projections of $Ret_{t+1} - Rf_{t+1}$. Thus, the difference between the two projections show (approximately) how the residual return component reacts to monetary policy surprises.

C. Details on flow-induced price pressures

A feature of our analysis is to measure the joint response of prices and *quantities* to the revelation of monetary policy news, in turn allowing us to better understand the economic nature of monetary policy surprises. A priori, large allocation changes by (some) market participants following a FOMC announcement could reflect a) information-based trading or b) disagreement among investors leading to transitory price pressure effects (e.g., Scholes (1972); Glosten and Milgrom (1985); Grossman and Miller (1988)).

To illustrate this idea in our setting, we follow the exposition of Hendershott and Menkveld (2014) and think of the observed (log) price of the stock market (p_t) to be the sum of an information component (or efficient price component, m_t) and an error component (s_t):

$$p_t = m_t + s_t.$$

The information (m_t) component is the price that reflects all "fundamental" information (e.g., about expected future cash flows and discount rates). When we observe positive fund flows around FOMC announcements, it suggests that that there must be one subset of investors who is seeking to increase exposure to the equity market. To cater for that demand, another group of market participants needs to be induced to sell.

There are at least two possible reasons for why we observe flows upon the realisation of news. First, fund flows might reflect superior information of a subset of investors and thus help to determine the efficient price (m_t).[39] Second, fund flows might reflect "disagreement" between investors. When investors disagree, we should see reallocations of risky assets from one group of investors to another group of investors. These reallocations in turn consume liquidity and, thus, ultimately give rise to

[39]This line of argument has been recently used by Berk and van Binsbergen (2016) to explain the cross-section of fund flows.

temporary "price pressures" reflected in a mean-reverting component (s_t).[40]

We note that this decomposition (m_t and s_t) is arbitrary and serves expositional purposes only. For example, Campbell (2017) shows that "disagreement" between investors leads to a excess volatility in the stochastic discount factor – similar to models with time-varying price of risk. In this sense, price pressure and disagreement can be also viewed as ultra-short term discount rate news.

If we assume that fund flows do not reflect superior information of some investors, we can expect that the information component (Δm_t) is uncorrelated with fund flows. This assumptions is in line with the empirical observation that events with high flows (risk shifts) come along with a reversal pattern and not with a drift in prices in the same direction. Moreover, this assumption implies that we can use fund flows to estimate the price pressure component that can be attributed to the consumption of liquidity by fund flows.

In Table 6, we regress daily S&P 500 excess returns on contemporaneous fund flows, $t-1$ lagged fund flows, the cumulative sum of fund flows from $t-2$ to $t-5$ and the cumulative sum of fund flows from $t-6$ to $t-20$. Using daily, weekly and monthly lags of flows is inspired by popular long-memory models of expected volatility, e.g., Corsi (2009). We interact fund flows with an FOMC dummy. The fitted value of this regression is the component of returns explained by fund flows. Under the assumption that fund flows have no informative component, this is also a measure of the price pressure component (Δs_t) and the unexplained part plus the constant of this regression can be interpreted as the information component (Δm_t). We use the fitted value of this regression as the "flow pressure component" of stock prices in Figure 6 (Section 4).

>>> TABLE 6 ABOUT HERE <<<

[40] Jotikasthira, Lundblad, and Ramadorai (2012) also study fund flow induced price pressure, and Greenwood and Shleifer (2014) show empirically that fund flows are related to investors subjective expectations about future returns.

Tables and Figures

Table 1: Monetary Policy Surprises

We collect the following seven variables around scheduled (96 events) and unscheduled (2) FOMC announcements from 01/2006 to 12/2017: simple changes of three month interest rates as proxied by Eurodollar futures (ED), simple changes of the two, five, and ten year treasury yields as proxied by treasury futures (TU, FV, TY, provided by Thomson Reuters Tick History, TR), the log change of the squared CBOE Volatility Index (VIX^2, provided by Tickdata), log changes of the Credit Default Spread Index of investment grade corporate bonds with a maturity of five years (CDX, provided by CMA Datavision), the log change of an equally weighted portfolio of foreign exchange futures (DOL, denomination is in FCUs for one USD; the FCs are: AUD, CAD, CHF, EUR, GBP, JPY, NZD, provided by TR). We normalize all seven variables by their event standard deviation. The event window is 90 minutes (-15m:+75m) if the announcement is not followed by a press conference (70) and is extended to the market close (-15m:close) if the announcement is followed by a press conference (28). In a first step, we run a principal component analysis on FOMC announcement days (98 observations) to extract statistical factors (results below "PCA on FOMC Days"). Following Swanson (2018), in a second step, we apply a standard (orthogonal) factor rotation on the first three principal components to extract economic monetary policy surprises (results below "Orthogonal Rotation"); {*} indicate our target matrix. The obtained monetary policy surprises are: "Short Rate" surprises, as these surprises load on short maturity yields; "Long Rate" surprises, as these surprises load on long maturity yields; and "Risk Shifts", as these surprises load negatively on risky assets (VIX^2, CDX, DOL).

	Monetary Policy Surprises					
	PCA on FOMC Days (#98)			**Orthogonal Rotation**		
	(1)	**(2)**	**(3)**	**"Short Rate"**	**"Long Rate"**	**"Risk Shifts"**
$\triangle ED(3M)$	0.33	-0.16	-0.83	0.90*	0.00	0.00
$\triangle TU(2Y)$	0.45	-0.25	-0.14	0.33	0.41	0.08
$\triangle FV(5Y)$	0.49	-0.12	0.28	-0.06	0.57	-0.03
$\triangle TY(10Y)$	0.46	-0.13	0.38	-0.16	0.59*	0.00
$\triangle log\left(VIX^2\right)$	0.15	0.64	-0.23	0.15	-0.13	-0.66*
$\triangle log(CDX)$	0.14	0.66	0.07	-0.13	-0.03	-0.67*
$\triangle log(DOL)$	0.45	0.21	0.10	0.03	0.38	-0.33
Var. expl., %	53.08	25.18	10.75			

Table 2: Response of Equity Returns & Flows to Monetary Policy Surprises

Panel A reports the response (b) of equity returns and equity flows ($X_{t|FOMC}$) to a unit standard deviation monetary policy surprise on FOMC days:

$$X_{t|FOMC} = a + b \times Monetary\ Policy\ Surprise_{j,t|FOMC} + \xi_{t|FOMC},$$

as well as average returns/flows conditional on observing a positive ($mu_{MP\ Surprise>0}$) or negative ($mu_{MP\ Surprise<0}$) monetary policy surprise. Event window equity returns are measured intraday by the S&P 500 index. The event window is 90 minutes (-15m:+75m) if the announcement is not followed by a press conference (70) and is extended to the market close (-15m:close) if the announcement is followed by a press conference (28). Daily equity returns are measured by daily (close:close) equity ETF returns, and daily equity flows are measured by daily (close:close) equity ETF flows. The monetary policy surprises include short rate surprises (SR), long rate surprises (LR), and risk shifts (RS) and are described in Table 1. The sample includes 98 FOMC announcements from 01/2006 to 12/2017. T-statistics are based on bootstrap standard errors that account for the fact that the regressors are estimated. Panel B reports the response of equity returns and equity flows from a control group experiment. We compute pseudo factor surprises on all days using a 90 minutes event window (11:00:12:30) when there are no monetary policy news. T-statistics are based on bootstrap standard errors without regessor resampling.

Panel A. Baseline (event window: -15m:+75m/close if followed by press conference)

	Equity Returns						**Equity Flows**		
	Event Window Returns			Daily Returns			Daily Flows		
	SR	LR	RS	SR	LR	RS	SR	LR	RS
b	-0.19	-0.13	0.70	-0.26	-0.21	0.67	-0.20	-0.25	0.33
$t(b)$	-2.40	-1.55	15.39	-1.89	-1.51	5.51	-1.73	-2.11	2.81
R^2	5.27	2.38	71.87	3.45	2.33	23.89	2.89	4.33	7.75
$mu_{MP\ Surprise>0}$	0.06	0.12	0.57	0.23	0.34	0.72	-0.17	0.11	0.28
$s.e.$	0.13	0.11	0.05	0.23	0.19	0.15	0.19	0.17	0.14
$mu_{MP\ Surprise<0}$	0.22	0.20	-0.63	0.47	0.42	-0.26	0.39	0.22	-0.05
$s.e.$	0.10	0.12	0.08	0.17	0.20	0.21	0.15	0.17	0.20

Panel B. Control group, reaction to pseudo surprises (all days using the event window 11:00 - 12:30)

	Equity Returns						**Equity Flows**		
	Event Window Returns			Daily Returns			Daily Flows		
	SR	LR	RS	SR	LR	RS	SR	LR	RS
b	0.04	0.12	0.25	0.01	0.12	0.25	0.01	0.04	0.09
$t(b)$	6.70	19.16	50.11	0.37	5.14	11.42	0.66	2.44	5.13
R^2	1.45	10.88	45.01	0.00	0.93	4.15	0.01	0.20	0.83

Table 3: Long-Horizon Effects of Monetary Policy Surprises

This table reports the effect of a unit standard deviation monetary policy surprise on daily fund returns (close-close) and daily fund flows on FOMC announcement days ($h = 0$), the cumulated impact over the next 5 days ($h = 5$), and the next 20 days ($h = 20$). Results are obtained from linear projections of the form:

$$X_{t\to t+h} = a_h + b_h \times Monetary\ Policy\ Surprise_{j,t} \times D_{FOMC,t} + \xi_{t+h},$$

where $X_{t\to t+h}$ is the cumulative fund return, or flow, from time t up to time $t + h$, $Monetary\,Policy\,Surprise_{j,t}$ is one of the three orthogonal monetary policy surprises measured intraday around FOMC announcements (see Table 1 for details), and $D_{FOMC,t}$ is a dummy variable which is one on FOMC announcement days. If another monetary policy announcement falls into the event window (-1d:+20d), we remove this event from the sample (18 cases, as listed in the Internet Appendix). The sample period is from 2006 to 2017 with 80 non-confounding FOMC announcements. T-statistics are based on bootstrap standard errors that account for the fact that the regressors are estimated.

	Returns, %			**Flows, %**		
	Equity-Bond	**Equity**	**Bond**	**Equity-Bond**	**Equity**	**Bond**
	Short Rate Surprises on FOMC Days					
b_0	-0.40	-0.38	0.03	-0.51	-0.54	0.07
$\sum_{h=0}^{5} b_h$	-0.27	-0.24	0.03	-0.86	-0.67	0.84
$\sum_{h=0}^{20} b_h$	-0.28	-0.35	-0.07	0.11	0.07	-0.05
t_0	-1.86	-1.77	0.76	-3.19	-3.58	0.46
$t_{\sum 5}$	-0.61	-0.57	0.32	-2.14	-1.59	1.85
$t_{\sum 20}$	-0.34	-0.44	-0.42	0.14	0.10	-0.05
	Long Rate Surprises on FOMC Days					
b_0	0.19	-0.03	-0.22	-0.16	-0.09	0.20
$\sum_{h=0}^{5} b_h$	0.70	0.36	-0.34	0.61	0.67	-0.33
$\sum_{h=0}^{20} b_h$	-0.06	-0.33	-0.27	0.29	0.76	0.25
t_0	0.94	-0.16	-6.61	-1.16	-0.68	1.46
$t_{\sum 5}$	1.70	0.90	-4.53	1.56	1.82	-0.82
$t_{\sum 20}$	-0.08	-0.48	-1.95	0.38	1.20	0.28
	Risk Shifts on FOMC Days					
b_0	0.61	0.70	0.09	0.45	0.53	-0.05
$\sum_{h=0}^{5} b_h$	0.47	0.58	0.12	0.89	0.64	-0.88
$\sum_{h=0}^{20} b_h$	-0.06	0.09	0.15	0.33	-0.56	-1.74
t_0	3.75	4.77	3.49	3.97	4.73	-0.42
$t_{\sum 5}$	1.45	1.81	1.90	2.92	2.16	-2.68
$t_{\sum 20}$	-0.10	0.16	1.41	0.57	-1.13	-2.38

Table 4: Other Risky Asset Classes and Risk Shifts

This table reports for an extended set of risky asset classes the effect of a unit standard deviation risk shift on daily fund returns (close-close) and daily fund flows on FOMC announcement days ($h = 0$), the cumulated impact over the next 5 business days ($h = 5$), and the next business 20 days ($h = 20$). Estimation and inference is as described in Table 3. The risky asset classes are proxied by long-short strategies based on Morningstar categories: "Corp.-Broad" is corporate minus all broad and US government bond funds, "HY-Broad" is high yield minus all broad and US government funds, "EM-US Bonds" is emerging market bond minus all broad and US government bond funds, and "EM-US Equities" is emerging market equity minus minus all US blend equity funds. The max. sample period is from 2006 to 2017 (EM-US Equities) and is shorter for the bond categories. #FOMC reports the number of non-confounding FOMC announcement days available.

Other Risky Asset Classes & Risk Shifts

	Bonds			**Equities**
	Corp.-Broad	**HY-Broad**	**EM-US**	**EM-US**
#FOMC	**57**	**57**	**54**	**80**
	Returns, %			
b_0	0.11	0.22	0.28	0.52
$\sum_{h=0}^{5} b_h$	0.19	0.18	0.43	0.23
$\sum_{h=0}^{20} b_h$	0.16	-0.11	0.16	0.91
t_0	4.94	3.27	4.98	4.10
$t_{\sum 5}$	3.34	1.11	3.17	0.76
$t_{\sum 20}$	1.56	-0.39	0.61	1.75
	Flows, %			
b_0	0.21	0.39	0.45	0.27
$\sum_{h=0}^{5} b_h$	1.21	1.65	1.82	1.14
$\sum_{h=0}^{20} b_h$	1.49	0.81	4.51	2.07
t_0	1.28	2.15	2.53	1.78
$t_{\sum 5}$	2.30	2.35	2.81	2.19
$t_{\sum 20}$	1.21	0.51	2.85	1.64

Table 5: Regression of Changes in Textual Sentiment on Monetary Policy Surprises

Regressions of changes in textual sentiment (ΔS_t) on monetary policy surprises separately and jointly. Sentiment is measured as the average sentiment score of all articles in Ravenpack News Analytics (www.ravenpack.com) related to *"United States Federal Reserve"* and *"Board of Governors of the Federal Reserve System"* in the x days before an FOMC meeting and separately for the x days after an FOMC meeting and we let x vary from $3, 5, 7, 10, ...14$ days. All articles entering the average sentiment score are weighted by their relevance score (ranging from $0, ..., 100$) so that articles with higher relevance receive a higher weight. We then compute the change in sentiment as the difference between the average, relevance-weighted sentiment scores in the post-FOMC window and then average, relevance-weighted sentiment scores in the pre-FOMC window. We do this for each of our 96 scheduled FOMC meetings to obtain a time-series of sentiment changes. To avoid timing issues we do not include the day before the FOMC decision and the day after the FOMC meeting in the computation of sentiment scores. For example, if the FOMC meetings ends on July 27th, 2016, the $x = 3$ day pre-FOMC window runs from July 22nd to 25th whereas the 3-day post-FOMC window runs from July 29th to 31st. t-statistics in squared brackets are based on White standard errors.

	Days Around FOMC Meeting				
	3	**5**	**7**	**10**	**14**
	Univariate Regression				
Short Rate Surprises	-1.30	-1.35	-0.69	0.94	2.45
t	[-1.25]	[-1.28]	[-0.69]	[0.91]	[1.43]
R^2	0.01	0.01	0.00	0.01	0.05
Long Rate Surprises	-3.33	-3.69	-2.76	-2.23	-2.12
t	[-2.93]	[-3.80]	[-3.16]	[-2.58]	[-2.36]
R^2	0.07	0.11	0.06	0.04	0.04
Risk Shifts	2.68	2.45	2.44	2.47	1.61
t	[2.06]	[2.18]	[2.29]	[2.06]	[1.04]
R^2	0.04	0.05	0.05	0.05	0.02
	Multivariate Regression				
Short Rate Surprises	-1.31	-1.36	-0.69	0.94	2.45
t	[-1.47]	[-1.58]	[-0.80]	[1.03]	[1.48]
Long Rate Surprises	-3.33	-3.69	-2.76	-2.23	-2.12
t	[-3.15]	[-4.03]	[-3.35]	[-2.64]	[-2.30]
Risk Shifts	2.68	2.44	2.44	2.47	1.61
t	[2.24]	[2.38]	[2.34]	[2.10]	[1.07]
adj. R^2	0.09	0.15	0.08	0.07	0.07

Table 6: Measuring Flow-Induced Price Pressure

This table reports properties of the "flow-induced price pressure" and the "information" component of S&P 500 excess returns. The return decomposition is based on a regression of daily S&P 500 excess returns on daily contemporaneous and lagged equity (ETF) flows:

$$R_t^e = constant + 0.27F_t + 0.00F_{t-1} - 0.01F_{t-5:t-2} - 0.01F_{t-20:t-6} + ...$$

$$... (0.13F_t + 0.22F_{t-1} + 0.05F_{t-5:t-2} - 0.04F_{t-20:t-6}) \times D_{FOMC,t} + \iota_t$$

The "information component" of S&P 500 excess returns is measured as the constant and the unexplained part: $R_{M,t}^e = constant + \iota_t$. The "flow-induced price pressure component" is the part explained by fund flows: $R_{S,t}^e = R_t^e - R_{M,t}^e$. The table reports the mean, standard deviation and the the R^2(in %) of a regression of the total excess return on the information or the flow-induced price pressure component. Results are reported for days that do not include FOMC announcements (ex FOMC), for FOMC announcement days (FOMC days), and for the 50% FOMC announcement days with the largest absolute risk shift (FOMC days, high absolute RS). The sample includes 98 FOMC announcements from 01/2006 to 12/2017.

	Total Excess Return	**Unexplained ("Information Component")**	**Flow-Induced Price Pressure Component**
	R_t^e	$R_{M,t}^e$	$R_{S,t}^e$
mean, ex FOMC days, %	0.02	0.02	0.00
mean, FOMC days, %	0.38	0.26	0.12
mean, FOMC days, high abs. RS, %	0.53	0.25	0.28
std, ex FOMC days, %	1.22	1.19	0.26
std, FOMC days, %	1.32	1.21	0.57
std, FOMC days, high abs. RS, %	1.50	1.30	0.59
	Total Excess Return (R_t^e) Explained by:		
	R_t^e	$R_{M,t}^e$	$R_{S,t}^e$
R^2, ex FOMC days	100 %	95 %	5 %
R^2, FOMC days	100 %	81 %	15 %
R^2, FOMC days, high abs. RS	100 %	85 %	26 %

Figure 1: Risk Shifts on FOMC Announcement Days

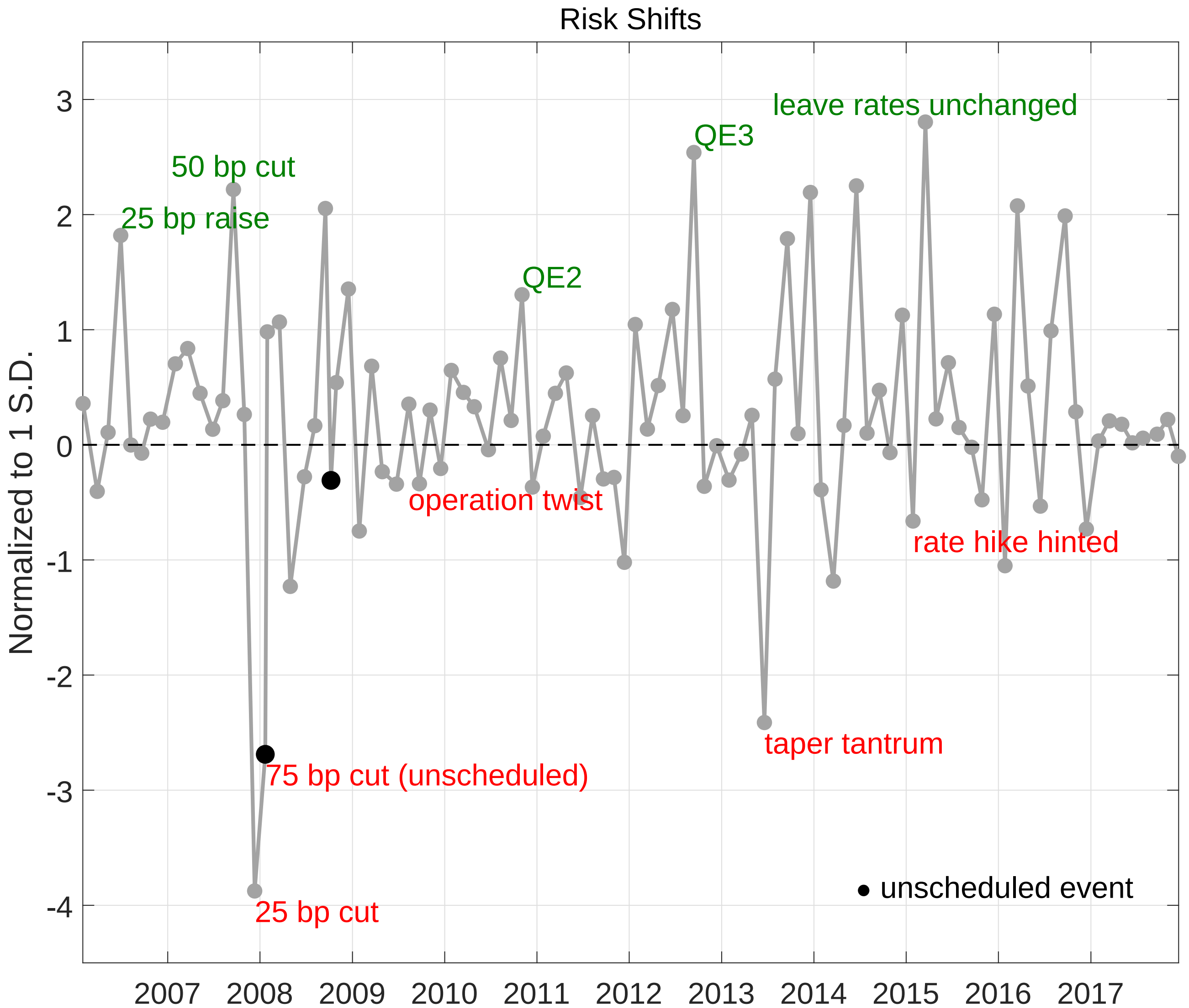
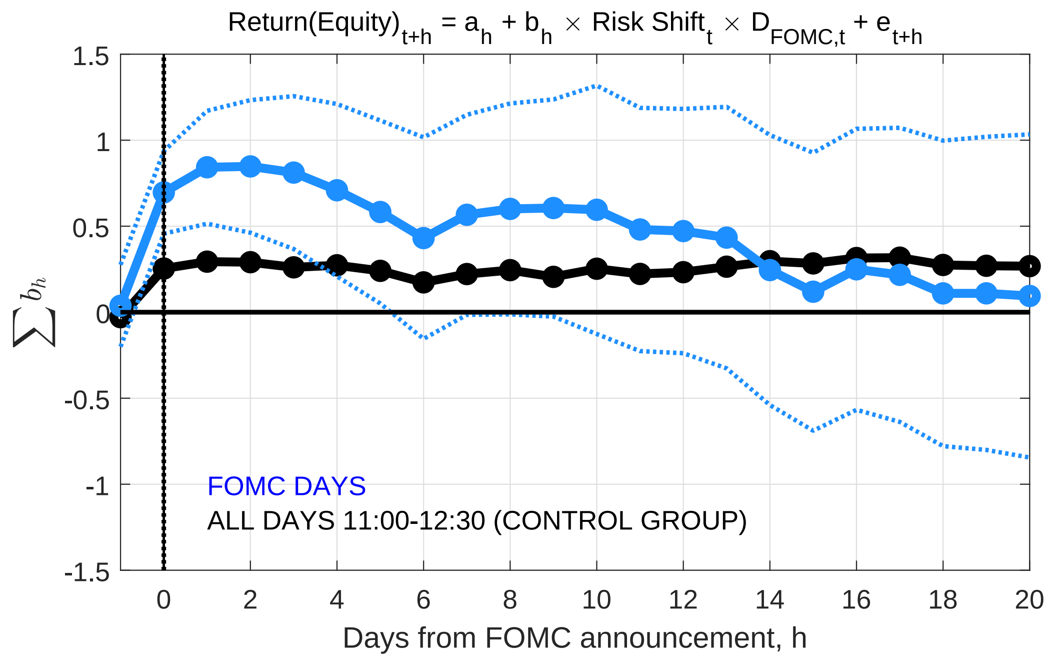


Figure 2: The FOMC Risk Shift



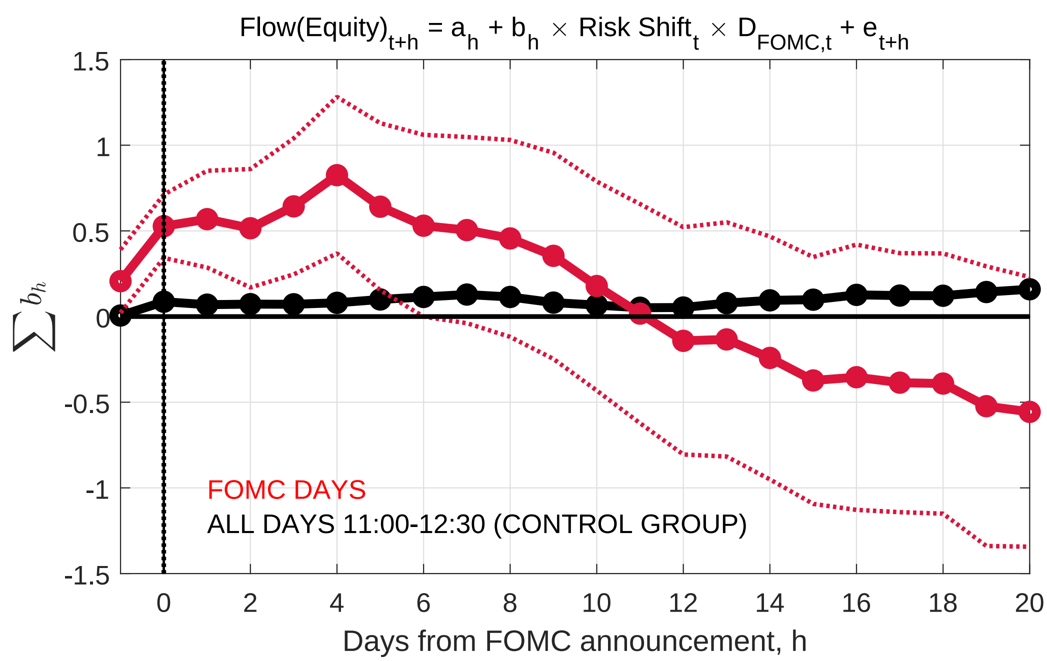


Figure 3: Return Composition: Discount Rate News

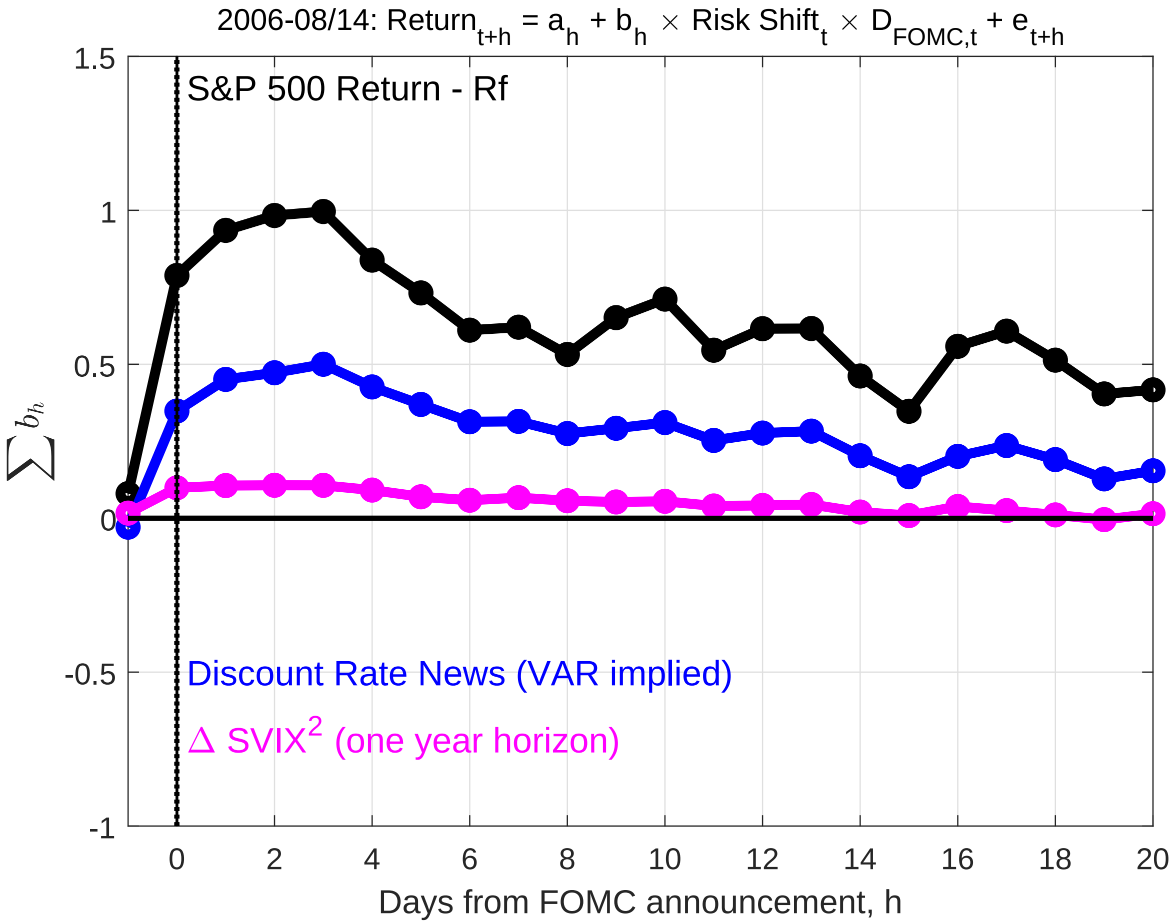


Figure 4: The SPDR S&P 500 ETF return on FOMC Days from 1998-2017

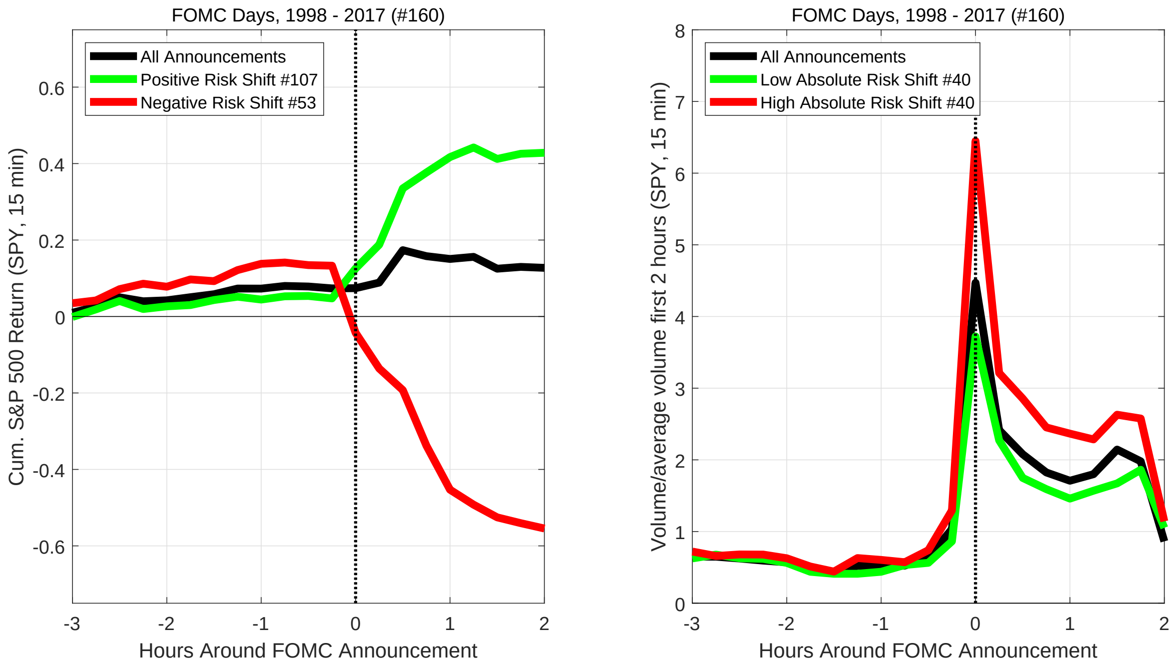
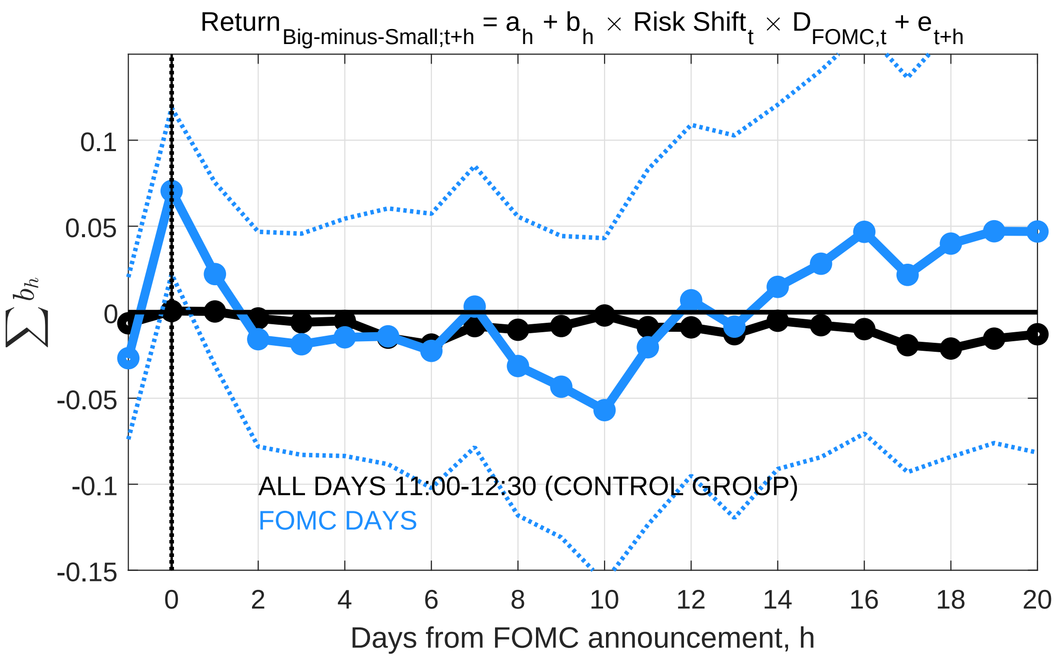


Figure 5: The Role of ETF Liquidity: Big minus Small Funds



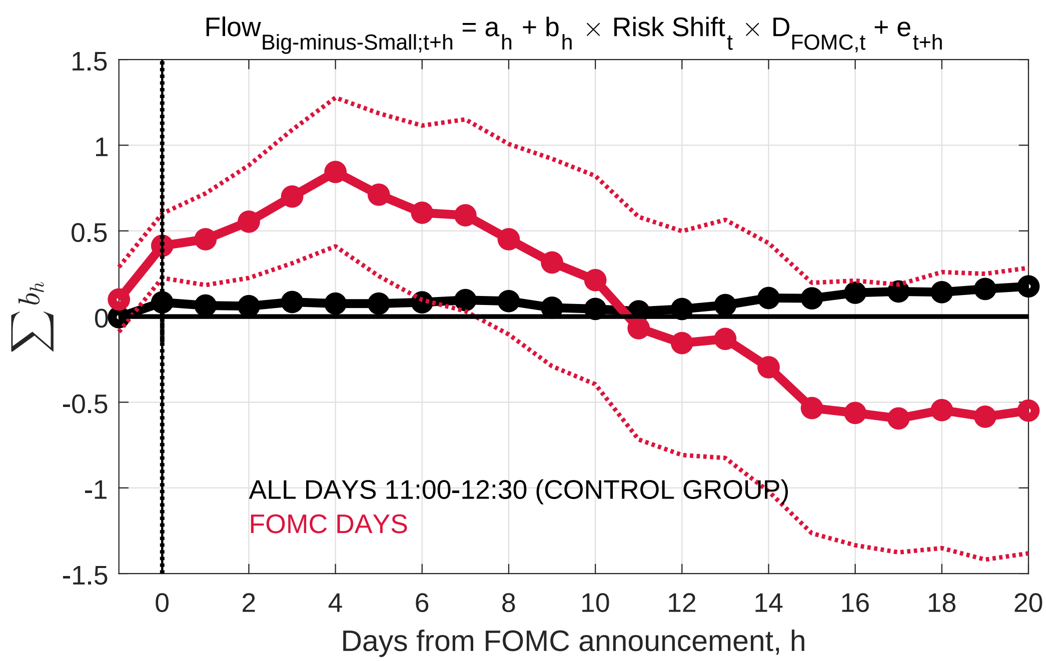


Figure 6: Fund Flow-Induced Price Pressures

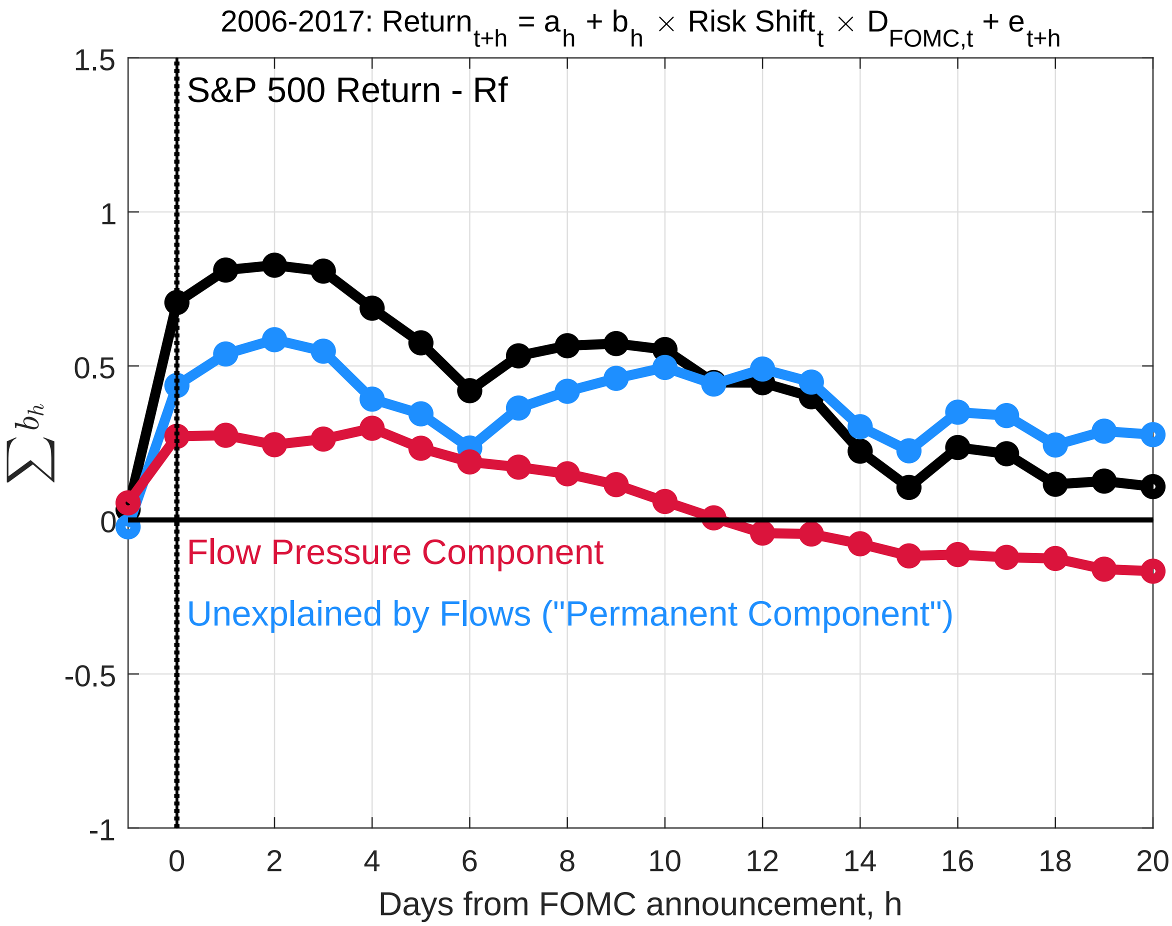


Figure 7: Intraday Returns: Extended Sample & Subsamples

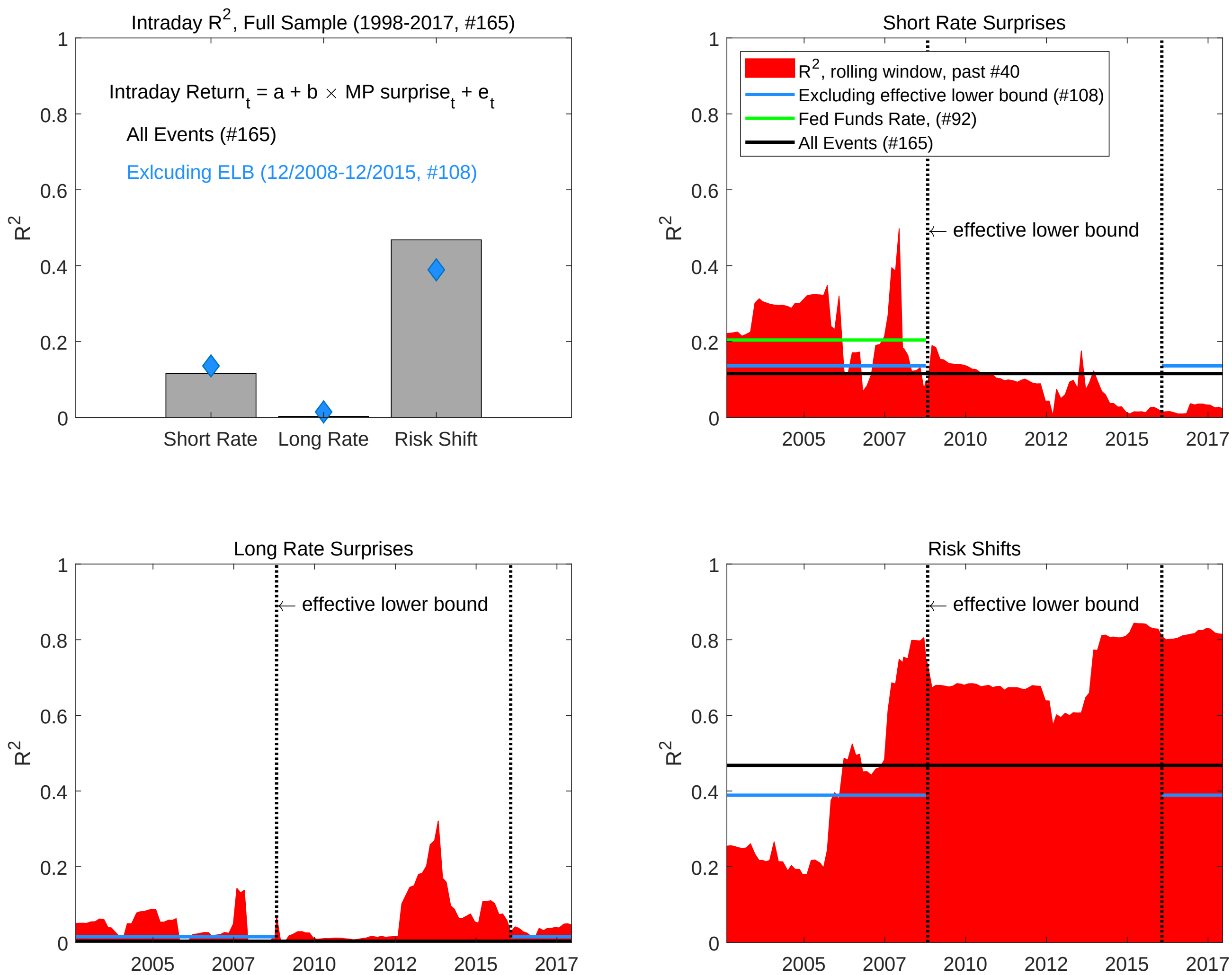
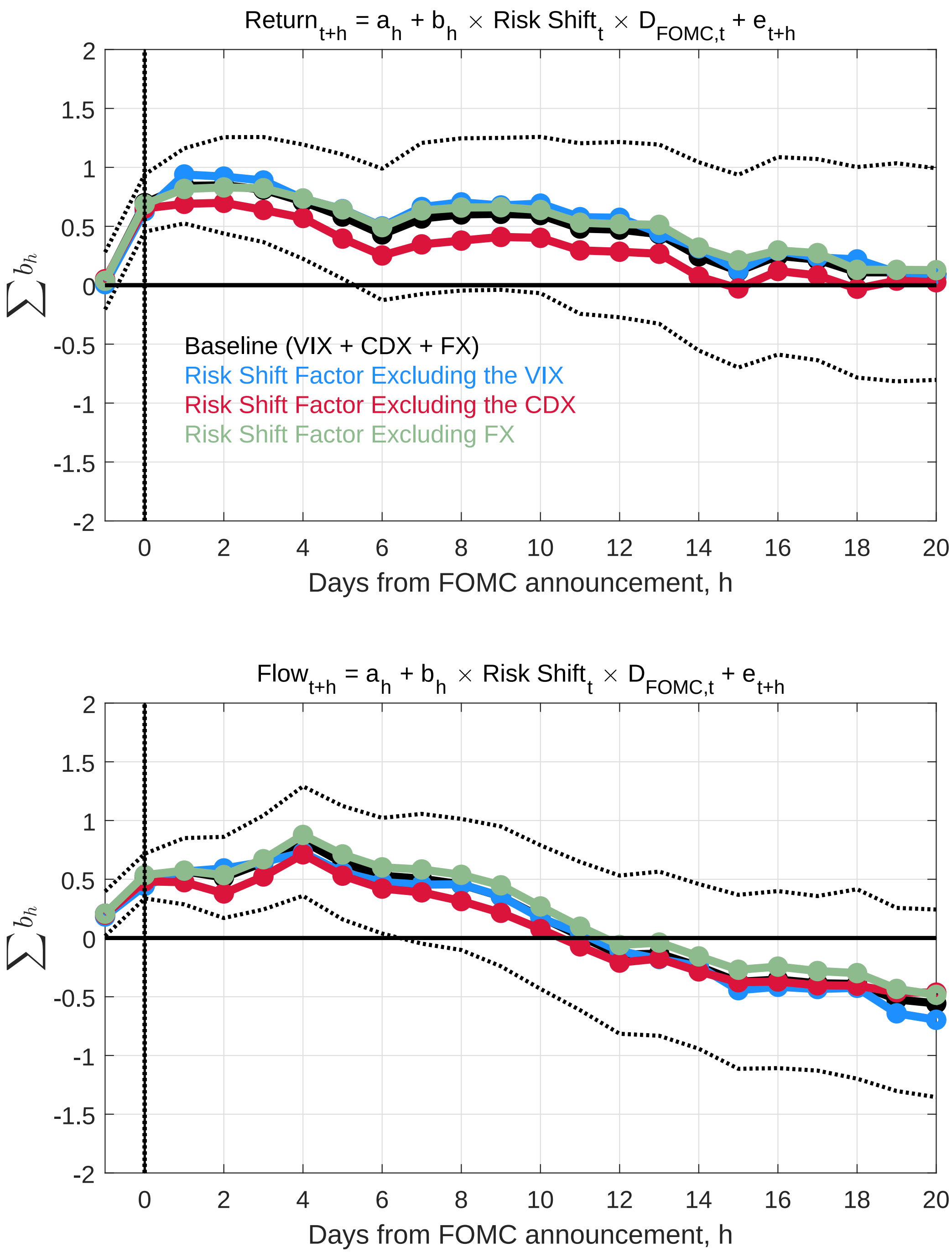


Figure 8: Alternative Risk Shift Factor: Dropping the VIX, CDX, or FX



Internet Appendix for

The FOMC Risk Shift

(not for publication)

Outline:

Section IA.A: Further results with discussion in the main paper

Section IA.B: Further results without discussion in the main paper

Section IA.C: Illustration of the spanning argument

IA.A. Further results with discussion in the main paper

Descriptive statistics and details on returns, flows, and events: Table IA.2 reports descriptive statistics for equity and bond fund returns, as well as flows. Remarkable is the modest degree of equity (bond) fund flow persistence, as indicated by variance ratios close to one (well below 2) at the 20-day horizon. Low persistence indicates that ETF flows, particularly in the case of equities, quickly respond to new information.

Table IA.3 provides the average announcement returns for the intraday event window as well as the three monetary policy surprises.

Our event list is provided in Table IA.4. This event list is obtained from the comprehensive database collected by Cieslak and Schrimpf (2018).

Figure IA.1 gives an overview on the ETF flow data that are available. The upper figure shows total assets under management for the equity and bond category that we employ in this paper. The lower figures shows the percentage of non-zero flows in the past 12 month. As discussed in Section 3 of the main paper, we observe fund flows almost every day when we start the sample in 2006.

Figures IA.2 and IA.3 visualize the short rate and long rate monetary policy surprises.

Extended Sample Period: Table IA.5 shows the results from the factor analysis (as in Table 1) using the extended (but less detailed) sample from 1998 - 2017. We then spline these monetary policy surprises from 1998 - 2005 with those from the more detailed dataset reported in Table 1 from 2006 - 2017.

Table IA.6 compares the effect of the three monetary policy surprises on even window S%P 500 returns across several sub-samples. These results are (in part) shown in Figure 7 of the main paper.

Table IA.7 compares our monetary policy surprises (short rate, long rate and risk shifts) to fed fund rate futures (from Gorodnichenko and Weber (2016)) and the rate surprises extracted from Eurodollar futures. These results are (in part) also shown in Figure 7 of the main paper.

Table IA.8 considers mulitvariate regressions where we also control for changes in the VIX. We find that the sub-sample where univariate regressions of stock returns on short rate proxies lead to the largest R^2 is also the sub-sample where short rate proxies tend to have the highest correlation to changes in the VIX. The full sample correlation is basically zero, however.

Variations in the event window: In Table IA.9 we re-consider the effect of the three monetary policy surprises on the stock market (as in Table 2 of the main paper) using a wider (Panel A) or a tighter (Panel B) event window. Panel B also ignores the information content of press conferences. We find that the tight event window results are qualitative similar to the baseline, but more muted during the event window for all three monetary policy surprises in our sample period. Interestingly, at the daily horizon, the results are very similar to the baseline. We find that the wide event window results are very similar to the baseline results, at the event window horizon and the daily horizon.

Robustness and further results: Figure IA.4 shows the longer horizon response of equity prices and flows to short rate and long rate surprises. This Figure visualizes Table 3 in the main paper.

Section 5 discusses several robustness checks. In this Internet Appendix, we provide the according results not reported in the main paper. We find that our baseline results are mainly robust to: excluding the financial crises, Figure IA.5; excluding events, or focusing on events, with press conferences Figure IA.6; including potentially confounding events, Figure IA.7

We also discuss that an alternative construction of risk shifts (that is based on a regression-based orthogonalization of a portfolio of risky assets) leads to similar results (Figure IA.8).

In contrast, macro economic news tend to generate a more persistent response (Figure IA.9).

The longer horizon response for the extended sample period can be found in Figure IA.10 and is discussed in Section 4.

Figure IA.11 shows fund flows of mutual fund instead of ETFs. As discussed in the main paper, we finnd that mutual fund flows do not respond in a meaningful way to FOMC risk shifts.

Figures IA.12, IA.13, IA.14 provide the results of an outlier analysis. We re-estimate the initial response of intraday returns, as well as daily fund returns and flows but with leaving one observation out. We find that FOMC risk shifts are unaffected. Results on the short rate and long rate surprises are more dependent on specific observations. This result squares well with the subsample analysis presented in Figure 7.

Discount rate news: VAR parameter estimates: In Section 4 of the main paper, we utilize the discount rates news estimated by a Campbell and Shiller (1988)/Campbell (1991)-VAR. The procedure is explained in Appendix B. Table IA.10 provides the parameter estimates.

Textual Analysis of Market Commentary: In Section 4 of the main paper, we discuss the results of an analysis of market commentary *on* FOMC days.

As mentioned in the main text, for his purpose, we collect market commentaries on the FOMC meeting from *Thomson Reuters Instant View*. *Thomson Reuters Instant View* collects and publishes views and commentary from market experts (e.g., traders, analysts, economists) on the outcome of the meeting shortly after an FOMC announcement (i.e., on the same day in the late afternoon). We always pick the complete *Thomson Reuters Instant View* column for each of our 96 scheduled FOMC announcements and do not select particular analysts or firms.

We then count the frequency of words that relates to economic and financial conditions or the surprise content of the news divided by the total number of words. Finally, we regress the absolute FOMC risk shift on the relative frequency of these words for the 96 scheduled FOMC meetings in our sample.

Tables IA.11, IA.12, and IA.13 show the results from regressions of the absolute of the three monetary policy surprises on the frequency of words that relates to economic and financial conditions or the surprise content of the news divided by the total number of words.

In Section 4 of the main paper, we discuss the results from a qualitative approach based on market commentary. In this context, we closely read through the market commentary around FOMC days with large risk shifts.

Tables IA.14 and IA.15 provide some illustrative commentaries on well known monetary policy events to illustrate our take away from this exercise.

IA.B. Further results without discussion in the main paper

Fama-French factors and monetary policy surprises: In Table IA.16, we provide results for regressions of the (daily) Fama and French (2015)-factors on our three monetary policy surprises on FOMC announcement days. For the Fama-French market factor, we find virtually the same results as for our fund data-based measure of the equity premium. However, we do not find interesting results for equity factor returns, like *size* and *value*.Interestingly, Neuhierl and Weber (2017) also do not find a differential drift around FOMC announcements for equity style premia. In unreported results, we also do not find significant flows from funds that invest in big stocks vs funds that invest in small stocks or from growth to value funds, in line with the evidence from prices.

The FOMC Risk Shift Cycle: Cieslak, Morse, and Vissing-Jorgensen (2018) detect a cycle in equity returns following the FOMC meeting schedule: returns are high in even weeks in FOMC meeting time. In Figure IA.15 of the Internet Appendix, we replicate their analysis for ETF fund returns and complement their results with ETF fund flows.[41] We find that even weeks are also weeks where investors shift on average from bond funds to equity funds and this pattern is mirrored in the average risk shift factor as well.

Cieslak, Morse, and Vissing-Jorgensen (2018) discuss potential mechanisms behind the FOMC cycle and argue that the FED reduces the amount of uncertainty via informal channels in even weeks. Our ETF fund flow results provide evidence that institutional investors are particulary sensitive to the FOMC cycle and seem to play a prominent role in this process. The fact that our FOMC risk shift factor also co-moves with returns and flows is in line with the idea that uncertainty and not news about rates drive the FOMC cycle.

[41] For this analysis, we rely on the extended sample dataset from 1998-2017, as introduced in the subsection before.

IA.C. Illustration of the spanning argument

This section illustrates our spanning argument: our risk shift factor filters news about the component of risky asset premia that is not spanned by risk-free rates. A simulation experiment illustrates that the described setup leads to a similar factor structure as can be observed in empirical data.

Changes in the risk-free rates (with maturity of 3 months, or 2, 5, and 10 years) are driven by the following dynamics:

$$\triangle y_t(3M) = l_{3M}\triangle Level_t + s_{3M}\triangle Slope_t,$$

$$\triangle y_t(2Y) = l_{2Y}\triangle Level_t + s_{2Y}\triangle Slope_t,$$

$$\triangle y_t(5Y) = l_{5Y}\triangle Level_t + s_{5Y}\triangle Slope_t,$$

$$\triangle y_t(10Y) = l_{10Y}\triangle Level_t + s_{10Y}\triangle Slope_t,$$

i.e., they are completely spanned by a "Level" and a "Slope" factor. These two factors are, in turn, determined by news about short-rates, NSR_t, and news about long-rates (e.g., driven by forward guidance), NLR_t , and a bond market specific component (news un-spanned by monetary policy):

$$\triangle Level_t = m_l NSR_t + f_l NLR_t + \vartheta_{l,t},$$

$$\triangle Slope_t = m_s NSR_t + f_s NLR_t + \vartheta_{s,t}.$$

Without loss of generality, and to facilitate the interpretation of the underlying factors, NSR_t and NLR_t can always be re-defined such that they are uncorrelated with each other.

In economic terms, the the two yield-based factors could capture news about expected short-term interest rates, expected economic growth, and expected inflation. Measured around a short window around FOMC announcements, these terms capture news about short and long rates revealed by monetary policy news.

Risky assets: Following present-value logic (Campbell (1991); Campbell and Shiller (1988)), an unanticipated change in the stock market price must come from changes in the required rate of return (discount rate news: $NDR_{Mt} = (E_t - E_{t-1})\sum_{j=1}^{\infty}\rho^j r_{t+j}$) or cash flow news ($NCF_{Mt} = (E_t - E_{t-1})\sum_{j=0}^{\infty}\rho^j \triangle d_{t+j}$):

$$r_{Mt} - E_{t-1}(r_{Mt}) \approx NDR_{Mt} + NCF_{Mt}$$

Cash flow news are modelled as a function of the news that also drive the bond markets (NSR_t, NLR_t) plus a stock market specific component ($\vartheta_{CF,t}$):

$$NCF_{Mt} = m_{CF}NSR_t + f_{CF}NLR_t + \vartheta_{CF,t}.$$

Similarly, discount rate news are driven by economy wide factors (that can effect many asset classes) as well as a stock market specific component ($\vartheta_{DR,t}$). The economy wide components are driven by the same factors as the bond market (NSR_t,NLR_t) and in addition by changes in investors perception of risk, or a "risk shift" (NRS_t), that is specific to risky assets and absent in risk-free assets (i.e., uncorrelated with NSR_t,NLR_t, $\vartheta_{l,t}$, and $\vartheta_{s,t}$):

$$NDR_{Mt} = m_{DR}NSR_t + f_{DR}NLR_t + \gamma_{DR}NRS_t + \vartheta_{DR,t}.$$

In economic terms, "risk shifts" (NRS_t) could reflect the effects from a time-varying price of risk that are not reflected in risk-free yields, or changes in time-varying amount of risk that are also not reflected in risk-free yields. Measured around a short window around FOMC announcements, this component captures news about the perception of risk triggered by the revelation of monetary policy news.

To be clear, in equilibrium asset pricing models, changes in the price/amount of risk potentially also affect risk-free rates. However, they must do so differently compared to equities. Otherwise, if risk-free assets are driven by the identical factors as risky assets, the equity premium would be completely spanned by risk-free rates which would be counterfactual to the empirically observed large equity premium as well as a large theoretical literature.

Following similar arguments, changes of other risky asset prices also load on the the structural factors defined above:

$$\Delta log(VIX^2) \approx m_{VIX}NSR_t + f_{VIX}NLR_t + \gamma_{VIX}NRS_t + \vartheta_{VIX,t}$$

$$\Delta log(CDX) \approx m_{CDX}NSR_t + f_{CDX}NLR_t + \gamma_{CDX}NRS_t + \vartheta_{CDX,t}$$

$$\Delta log(DOL) \approx m_{DOL}NSR_t + f_{DOL}NLR_t + \gamma_{DOL}NRS_t + \vartheta_{DOL,t}$$

plus asset market specific components, $\vartheta_{VIX,t}, \vartheta_{CDX,t}, \vartheta_{DOL,t}$. For example, Bollerslev, Tauchen, and Zhou (2009) show that in a structural asset pricing model, changes in the amount of risk lead to changes in the risk-neutral volatility. Martin (2017) shows that risk-neutral volatility serves under certain conditions as the lower bound of the equity premium. The classic paper by Merton (1974) argues that credit risk premia are linked to the equity premium (and cash flows); e.g., Seo and Wachter (2018) for a recent paper. A recent literature argues that movements in the dollar are related to monetary policy uncertainty, or more generally, have become a barometer of risk (e.g., Mueller, Tahbaz-Salehi, and Vedolin (2017); Avdijev, Du, Koch, and Shin (2017)).

Importantly we allow all risky assets to be subject to asset class specific drivers of "re-pricing", $\vartheta_{CF,t}, \vartheta_{DR,t}, \vartheta_{VIX,t}, \vartheta_{CDX,t}, \vartheta_{DOL,t}$. In this sense, NRS_t represents economy wide re-pricing of "all" risky assets, not just equities. Finally, notice that we do not need to take a strong view on how much (or if any) a particular risky asset load on the three structural factors. The only identifying assumption we require is that risky assets load on NRS_t and that the risk-free assets do not load on NRS_t. Put differently, we assume that the risky assets market premium is unspanned by the factors driving risk-free rates.

Principal Component Analysis: To filter the structural factors (NSR_t, NLR_t, NRS_t) from a cross-section of asset prices we follow the two-step procedure put forth by Gürkaynak, Sack, and Swanson (2005) and Swanson (2018). In this paper, we will mainly study the re-pricing of the equity market. To avoid that our filtered risk shift factor ($\triangle RS_t = \widehat{NRS_t}$) mechanically explains equity returns (because of the two equity market specific components, $\vartheta_{CF,t}, \vartheta_{DR,t}$) we do not include equities in the principal component analysis. Instead, we include a diversified pool *other* risky assets - the VIX, the CDX, and the DOL - that should allow us to identify NRS_t.

Of course, ideally, we would like to further expand the cross-section of risky assets. Due to (intraday) data availability, however, this is not possible. We argue that this issue does not drive our results. First, the asset market specific components ($\vartheta_{VIX,t}, \vartheta_{CDX,t}, \vartheta_{DOL,t}$) add, if anything, asset market specific "noise" to our risk shift factor. This should work against identifying the relationship between risk shifts and the equity market. Second, in the robustness section, we exclude one of the three "other" risky asset markets before running the factor analysis (i.e. one of the three components $\vartheta_{VIX,t}, \vartheta_{CDX,t}, \vartheta_{DOL,t}$ at the time is removed from our risk shift factor). We find that our results are almost unaffected, which indicates that the asset market specific components are indeed relatively well diversified. In line with this finding, we find that the three factors that we extract in our factor analysis explain 80%+ of the variance in the cross-section of assets; which suggests that asset market specific news are relatively small.

Simulation: We run a simulation experiment to illustrate that the described setup is in line with the empirical factor structure that we document.

We simulate 1000 artificial data with the following properties: All economy wide news (NSR_t, NLR_t, NRS_t) are Gaussian and normalized to a unit standard deviation. All asset market specific news ($\vartheta_{CF,t}, \vartheta_{DR,t}, \vartheta_{VIX,t}, \vartheta_{CDX,t}, \vartheta_{DOL,t}$) are Gaussian with a standard deviation of 0.30. The loadings for the level and slope factors are: $m_l = 0.50$, $f_l = 0.50$, $m_s = -0.50$, $f_s = 1.00$, and the yield coefficients are: $l_{3M} = 1.0$, $s_{3M} = 0.0$, $l_{2Y} = 1.0$, $s_{2Y} = 0.50$, $l_{5Y} = 1.0$, $s_{5Y} = 0.75$, $l_{10Y} = 1.0$, $s_{10Y} = 1.00$.

For the risky assets, we set the loadings on the news terms to: $m_{VIX} = 0.20$, $f_{VIX} = -0.20$ $\gamma_{VIX} = 0.80$; $m_{CDX} = 0.20$, $f_{CDX} = 0.00$, $\gamma_{CDX} = 0.80$; $m_{DOL} = 0.20$, $f_{DOL} = 0.40$, $\gamma_{DOL} = 0.40$. We then standardize all seven innovations in asset prices and run the factor analysis as in the main paper.

The result is reported in Table IA.1. The first PCA reflects that all assets load on short-rate news. The second PCA captures that there is variation in risky asset prices that is not present in the risk-free assets. Finally, the third PCA reflects that long-term yields load on an additional long-rate factors. The factor rotation then facilitates the interpretation of the factors. The lower right of the table shows the R^2 of a regression of the filtered news, e.g. $\triangle RS_t = \widehat{NRS_t}$, on the true news NRS_t. We find that the filtered factors recover between 80% and 90% of the true factors.

Table IA.1: Simulated Monetary Policy Surprises

	Simulated Monetary Policy Surprises					
	PCA			**Orthogonal Rotation**		
	(1)	**(2)**	**(3)**	**"Short Rate"**	**"Long Rate"**	**"Risk Shift"**
$\triangle Y(3M)$	0.43	-0.02	-0.85	0.96	0.00	0.00
$\triangle Y(2Y)$	0.48	-0.13	-0.01	0.23	0.44	0.00
$\triangle Y(5Y)$	0.47	-0.16	0.23	0.01	0.54	0.00
$\triangle Y(10Y)$	0.46	-0.17	0.39	-0.13	0.61	0.00
$\triangle log\left(VIX^2\right)$	0.03	0.64	-0.11	0.10	-0.21	-0.61
$\triangle log(CDX)$	0.12	0.63	0.13	-0.08	-0.02	-0.64
$\triangle log(DOL)$	0.37	0.35	0.21	-0.02	0.30	-0.46
Var. expl., % / Recovered, %	59.74	31.76	4.08	80.31	87.23	90.00

Internet Appendix: Tables

Table IA.2: Descriptive Statistics: Daily Fund Returns and Flows

This table reports descriptive statistics for daily ETF fund returns and ETF fund flows (as studied in Tables 2 and 3 of the main paper). The reported statistics are the mean (*mu*, % p.d.) and standard deviation (*s.d.*, % p.d.), the variance ratio (vr_h) computed for horizons from $h = 2$ up to $h = 20$ days, the number of zero observations (#*zeros*), and the number of total observations (#*obs*). The lower panel reports conditional moments for the 98 scheduled and unscheduled FOMC announcements from 01/02/2006 to 12/30/2017.

	Returns, %			**Flows, %**		
	"Equity Premium"			**"Equity Premium"**		
	Equity-Bond	**Equity**	**Bond**	**Equity-Bond**	**Equity**	**Bond**
	All Observations					
mu	0.03	0.04	0.01	0.00	0.00	-0.01
s.d.	1.33	1.25	0.22	0.95	0.95	0.94
vr_2	0.92	0.93	0.96	1.11	1.11	1.07
vr_5	0.80	0.82	0.88	1.24	1.16	1.36
vr_{10}	0.70	0.73	0.81	1.25	1.03	1.64
vr_{20}	0.66	0.69	0.87	1.33	0.92	2.04
#*zeros*	0	0	0	0	0	72
#*obs*	3019	3019	3019	3019	3019	3019
	FOMC Announcement Days (t=0)					
mu	0.34	0.38	0.04	0.11	0.16	0.17
s.d.	1.40	1.38	0.33	1.29	1.20	1.52
#*obs*	98	98	98	98	98	98

Table IA.3: Average FOMC Returns and Monetary Policy Surprises

This table reports average means (% p.d.) with standard errors (s.e.) for the intraday S&P 500 returns and the three monetary policy surprises (as studied in Tables 1 and 2 of the main paper).

	Intraday Event Window Around FOMC Announcements			
	Returns	**Monetary Policy Surprises**		
	S&P 500, %	**Short Rate**	**Long Rate**	**Risk Shift**
mu	0.15	-0.19	-0.06	0.26
s.e.	0.08	0.10	0.10	0.10
$\#pos : \#neg$	61:37	39:59	52:46	64:34

Table IA.4: Event List of FOMC Announcements: 1998-2017

No.	Date and Time	Scheduled	Unsched.	With PC	Confounding and Date		Distance	Description
1	04.02.1998 14:12	1	0	0	0			
2	31.03.1998 14:12	1	0	0	0			
3	19.05.1998 14:15	1	0	0	0			
4	01.07.1998 14:15	1	0	0	0			
5	18.08.1998 14:12	1	0	0	0			
6	29.09.1998 14:15	1	0	0	1	15.10.1998 15:15	16	Unscheduled FOMC Rate Decision
7	15.10.1998 15:15	0	1	0	0			
8	17.11.1998 14:15	1	0	0	0			
9	22.12.1998 14:15	1	0	0	0			
10	03.02.1999 14:15	1	0	0	0			
11	30.03.1999 14:15	1	0	0	0			
12	18.05.1999 14:15	1	0	0	0			
13	30.06.1999 14:15	1	0	0	0			
14	24.08.1999 14:15	1	0	0	0			
15	05.10.1999 14:15	1	0	0	0			
16	16.11.1999 14:15	1	0	0	0			
17	21.12.1999 14:15	1	0	0	0			
18	02.02.2000 14:15	1	0	0	0			
19	21.03.2000 14:15	1	0	0	0			
20	16.05.2000 14:15	1	0	0	0			
21	28.06.2000 14:15	1	0	0	0			
22	22.08.2000 14:15	1	0	0	0			
23	03.10.2000 14:15	1	0	0	0			
24	15.11.2000 14:15	1	0	0	0			
25	19.12.2000 14:15	1	0	0	1	03.01.2001 13:15	15	Unscheduled FOMC Rate Decision
26	03.01.2001 13:15	0	1	0	0			
27	31.01.2001 14:15	1	0	0	0			
28	20.03.2001 14:15	1	0	0	0			
29	18.04.2001 10:55	0	1	0	1	15.05.2001 14:15	27	Scheduled FOMC Rate Decision
30	15.05.2001 14:15	1	0	0	0			
31	27.06.2001 14:12	1	0	0	0			
32	21.08.2001 14:15	1	0	0	1	17.09.2001 08:20	27	Unscheduled FOMC Rate Decision
33	02.10.2001 14:15	1	0	0	0			
34	06.11.2001 14:20	1	0	0	0			
35	11.12.2001 14:14	1	0	0	0			
36	30.01.2002 14:15	1	0	0	0			
37	19.03.2002 14:15	1	0	0	0			
38	07.05.2002 14:15	1	0	0	0			
39	26.06.2002 14:15	1	0	0	0			
40	13.08.2002 14:15	1	0	0	0			
41	24.09.2002 14:15	1	0	0	0			
42	06.11.2002 14:14	1	0	0	0			
43	10.12.2002 14:15	1	0	0	0			
44	29.01.2003 14:16	1	0	0	0			
45	18.03.2003 14:15	1	0	0	0			
46	06.05.2003 14:13	1	0	0	0			
47	25.06.2003 14:15	1	0	0	0			
48	12.08.2003 14:15	1	0	0	0			
49	16.09.2003 14:19	1	0	0	0			
50	28.10.2003 14:15	1	0	0	0			
51	09.12.2003 14:15	1	0	0	0			
52	28.01.2004 14:15	1	0	0	0			
53	16.03.2004 14:15	1	0	0	0			
54	04.05.2004 14:15	1	0	0	0			
55	30.06.2004 14:15	1	0	0	0			
56	10.08.2004 14:15	1	0	0	0			
57	21.09.2004 14:15	1	0	0	0			
58	10.11.2004 14:15	1	0	0	0			
59	14.12.2004 14:15	1	0	0	0			
60	02.02.2005 14:15	1	0	0	0			
61	22.03.2005 14:15	1	0	0	0			
62	03.05.2005 14:15	1	0	0	0			
63	30.06.2005 14:15	1	0	0	0			
64	09.08.2005 14:15	1	0	0	0			
65	20.09.2005 14:15	1	0	0	0			
66	01.11.2005 14:15	1	0	0	0			
67	13.12.2005 14:15	1	0	0	0			

Table IA.4 continued...

No.	Date and Time	Scheduled	Unsched.	With PC	Confounding and Date		Distance	Description
68	31.01.2006 14:14	1	0	0	0			
69	28.03.2006 14:15	1	0	0	0			
70	10.05.2006 14:15	1	0	0	0			
71	29.06.2006 14:15	1	0	0	0			
72	08.08.2006 14:15	1	0	0	0			
73	20.09.2006 14:15	1	0	0	0			
74	25.10.2006 14:15	1	0	0	0			
75	12.12.2006 14:15	1	0	0	0			
76	31.01.2007 14:15	1	0	0	0			
77	21.03.2007 14:15	1	0	0	0			
78	09.05.2007 14:15	1	0	0	0			
79	28.06.2007 14:15	1	0	0	0			
80	07.08.2007 14:15	1	0	0	0			
81	18.09.2007 14:15	1	0	0	0			
82	31.10.2007 14:15	1	0	0	0			
83	11.12.2007 14:15	1	0	0	1	12.12.2007 05:03	1	Announcement of Unconventional MP
84	22.01.2008 08:20	0	1	0	1	30.01.2008 14:15	8	Scheduled FOMC Rate Decision
85	30.01.2008 14:15	1	0	0	0			
86	18.03.2008 14:15	1	0	0	0			
87	30.04.2008 14:15	1	0	0	1	02.05.2008 04:11	2	Announcement of Unconventional MP
88	25.06.2008 14:15	1	0	0	0			
89	05.08.2008 14:15	1	0	0	0			
90	16.09.2008 14:15	1	0	0	1	18.09.2008 02:55	2	Announcement of Unconventional MP
91	08.10.2008 07:00	0	1	0	1	13.10.2008 02:00	5	Announcement of Unconventional MP
92	29.10.2008 14:17	1	0	0	1	25.11.2008 08:15	27	Announcement of Unconventional MP
93	16.12.2008 14:15	1	0	0	1	19.12.2008 08:02	3	Announcement of Unconventional MP
94	28.01.2009 14:15	1	0	0	1	03.02.2009 08:00	6	Announcement of Unconventional MP
95	18.03.2009 14:15	1	0	0	1	19.03.2009 04:25	1	Announcement of Unconventional MP
96	29.04.2009 14:15	1	0	0	0			
97	24.06.2009 14:15	1	0	0	1	25.06.2009 12:00	1	Announcement of Unconventional MP
98	12.08.2009 14:15	1	0	0	0			
99	23.09.2009 14:15	1	0	0	1	24.09.2009 10:00	1	Announcement of Unconventional MP
100	04.11.2009 14:15	1	0	0	0			
101	16.12.2009 14:15	1	0	0	0			
102	27.01.2010 14:15	1	0	0	0			
103	16.03.2010 14:15	1	0	0	0			
104	28.04.2010 14:15	1	0	0	1	10.05.2010 21:18	12	Announcement of Unconventional MP
105	23.06.2010 14:15	1	0	0	0			
106	10.08.2010 14:15	1	0	0	1	27.08.2010 10:00	17	Bernanke speech, Jackson Hole
107	21.09.2010 14:15	1	0	0	1	15.10.2010 08:15	24	Bernanke speech, Boston Fed
108	03.11.2010 14:15	1	0	0	0			
109	14.12.2010 14:15	1	0	0	1	21.12.2010 09:00	7	Announcement of Unconventional MP
110	26.01.2011 14:15	1	0	0	0			
111	15.03.2011 14:15	1	0	0	0			
112	27.04.2011 12:30	1	0	1	0			
113	22.06.2011 12:30	1	0	1	1	22.06.2011 14:15	7	Announcement of Unconventional MP
114	09.08.2011 14:15	1	0	0	1	26.08.2011 10:00	17	Bernanke speech, Jackson Hole
115	21.09.2011 14:15	1	0	0	0			
116	02.11.2011 12:30	1	0	1	0			
117	13.12.2011 14:15	1	0	0	0			
118	25.01.2012 12:30	1	0	1	0			
119	13.03.2012 14:15	1	0	0	0			
120	25.04.2012 12:30	1	0	1	0			
121	20.06.2012 12:30	1	0	1	0			
122	01.08.2012 14:15	1	0	0	0			
123	13.09.2012 12:30	1	0	1	0			
124	24.10.2012 14:15	1	0	0	0			
125	12.12.2012 12:30	1	0	1	0			
126	30.01.2013 14:15	1	0	0	0			
127	20.03.2013 14:00	1	0	1	0			
128	01.05.2013 14:00	1	0	0	1	22.05.2013 10:00	21	Bernanke Testimony
129	19.06.2013 14:00	1	0	1	0			
130	31.07.2013 14:00	1	0	0	0			
131	18.09.2013 14:00	1	0	1	0			
132	30.10.2013 14:00	1	0	0	0			
133	18.12.2013 14:00	1	0	1	0			
134	29.01.2014 14:00	1	0	0	0			
135	19.03.2014 14:00	1	0	1	0			
136	30.04.2014 14:00	1	0	0	0			
137	18.06.2014 14:00	1	0	1	0			
138	30.07.2014 14:00	1	0	0	0			
139	17.09.2014 14:00	1	0	1	0			
140	29.10.2014 14:00	1	0	0	0			
141	17.12.2014 14:00	1	0	1	0			
142	28.01.2015 14:00	1	0	0	0			
143	18.03.2015 14:00	1	0	1	0			
144	29.04.2015 14:00	1	0	0	0			
145	17.06.2015 14:00	1	0	1	0			
146	29.07.2015 14:00	1	0	0	0			
147	17.09.2015 14:00	1	0	1	0			
148	28.10.2015 14:00	1	0	0	0			
149	16.12.2015 14:00	1	0	1	0			
150	27.01.2016 14:00	1	0	0	0			
151	16.03.2016 14:00	1	0	1	0			
152	27.04.2016 14:00	1	0	0	0			
153	15.06.2016 14:00	1	0	1	0			
154	27.07.2016 14:00	1	0	0	0			
155	21.09.2016 14:00	1	0	1	0			
156	02.11.2016 14:00	1	0	0	0			
157	14.12.2016 14:00	1	0	1	0			
158	01.02.2017 14:00	1	0	0	0			
159	15.03.2017 14:00	1	0	1	0			
160	03.05.2017 14:00	1	0	0	0			
161	14.06.2017 14:00	1	0	1	0			
162	26.07.2017 14:00	1	0	0	0			
163	20.09.2017 14:00	1	0	1	0			
164	01.11.2017 14:00	1	0	0	0			
165	13.12.2017 14:00	1	0	1	0			

Table IA.5: Monetary Policy Surprises: Extended Sample (1998 - 2017)

Monetary factor extraction as described in Table 1 of the main paper, but for an extended sample starting in 1998. The VIX is the only risky asset; VIX data for the extended sample period are from kibot.com.

	Monetary Policy Surprises					
	PCA on FOMC Days (#165)			**Orthogonal Rotation**		
	(1)	**(2)**	**(3)**	**"Short Rate"**	**"Long Rate"**	**"Risk Shift"**
$\triangle ED(3M)$	0.34	0.10	-0.90	0.97*	0.00	0.00
$\triangle TU(2Y)$	0.52	-0.14	-0.04	0.21	0.49	0.09
$\triangle FV(5Y)$	0.56	-0.07	0.24	-0.04	0.61	-0.03
$\triangle TY(10Y)$	0.54	-0.10	0.33	-0.13	0.62*	0.00
$\triangle log\left(VIX^2\right)$	0.13	0.98	0.14	0.02	0.03	-1.00*
Var. expl.,%	57.96	19.49	15.68			

Table IA.6: Extended Sample Period Results, 1998 - 2017

This table considers an extended sample period going back to 1998. For the period 1998-2005, monetary policy surprises are recalculated using the four interest rates (3 months, 2 years, 5 years, 10 years) plus the VIX (see Table IA.5). The extended (full) sample covers 165 FOMC announcements from 1998 to 2017. Results provided for subsample refer to the period before rates hit the effective lower bound (1998-11/2008) and when we exclude the period when rate hit the effective lowe bound (12/2008-12/2015). T-statistics are based on bootstrap standard errors.

Extended sample period results (-15m:+75m/close if followed by press conference)

	Full sample (1998-2017, #165)			Before ELB (1998-11/2008, #92)			Exclude ELB (ex.12/2008-12/2015, #108)		
	SR	LR	RS	SR	LR	RS	SR	LR	RS
b	-0.33	-0.05	0.73	-0.33	0.16	0.72	-0.33	0.13	0.71
$t(b)$	-4.69	-0.72	12.10	-3.97	1.39	7.40	-4.22	1.29	8.19
R^2	11.56	0.29	46.80	14.17	2.03	37.17	13.59	1.46	38.91
$mu_{MP\ Surprise>0}$	-0.04	0.15	0.47	-0.16	0.20	0.42	-0.17	0.19	0.40
$s.e.$	0.10	0.10	0.07	0.15	0.15	0.11	0.13	0.13	0.09
$mu_{MP\ Surprise<0}$	0.24	0.08	-0.68	0.32	-0.04	-0.81	0.29	-0.05	-0.80
$s.e.$	0.09	0.10	0.10	0.15	0.17	0.17	0.13	0.14	0.15

Table IA.7: Monetary Policy Factor Comparisons

This table compares different rate surprises extracted from fed fund futures and Eurodollar futures to our three monetary policy surprises. The data based on fed fund futures are taken from Gorodnichenko and Weber (2016).

	Intraday Returns and Monetary Policy Surprises														
	1998 - 11/2008 (#92)					1998 - 2005 (#67)					2006 - 11/2008 (#25)				
	FFR	*ED*	*SR*	*LR*	*RS*	*FFR*	*ED*	*SR*	*LR*	*RS*	*FFR*	*ED*	*SR*	*LR*	*RS*
b	-5.17	-4.49	-0.32	0.14	0.69	-8.57	-7.58	-0.52	0.07	0.80	1.25	-1.63	-0.13	0.37	0.61
$t(b)$	-4.85	-3.69	-3.89	1.21	8.10	-7.91	-4.15	-4.37	0.50	5.02	0.70	-1.03	-1.24	1.94	9.95
R^2	20.41	12.33	13.29	1.53	38.59	46.41	21.47	21.75	0.36	28.14	1.88	3.96	5.32	12.04	80.28

Table IA.8: Short Rate Surprises and Risk Shifts

This table compares results from our monetary policy surprises to changes in Fed funds rates (FFR) and simple changes in three month rates (Eurodollar, ED). The Fed funds rate data come from Gorodnichenko and Weber (2016). Data sources of the the other data are described in Table 1. In Panel A, we control for change in the VIX, while Panel B provides the results ffrom univariate regressions. Panel C shows the correlation coefficient between changes in rates and changes in the VIX. T-statistics are based on bootstrap standard errors.

Panel A. Fed funds rate (FFR) / three-month rate (ED) surprises with controlling for VIX

Intraday Returns and Monetary Policy Surprises (-15m:+75m)

	1998 - 11/2008 (#92)		1998 - 2005 (#67)		2006 - 11/2008 (#25)	
	FFR	*ED*	*FFR*	*ED*	*FFR*	*ED*
$\triangle RATES_{t\|FOMC}$	-5.29	-3.35	-7.73	-5.90	-0.69	-0.98
t	-7.04	-3.58	-8.52	-3.70	-0.89	-1.39
$\triangle log(VIX^2_{t\|FOMC})$	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07
t	-9.63	-7.99	-6.46	-5.14	-10.47	-10.34
R^2	61.70	47.13	67.12	42.60	82.16	83.01

Panel B. Fed funds rate (FFR) / three-month rate (ED) surprises without controlling for VIX

Intraday Returns and Monetary Policy Surprises (-15m:+75m)

	1998 - 11/2008 (#92)		1998 - 2005 (#67)		2006 - 11/2008 (#25)	
	FFR	*ED*	*FFR*	*ED*	*FFR*	*ED*
$\triangle RATES_{t\|FOMC}$	-5.17	-4.49	-8.57	-7.58	1.25	-1.63
t	-4.88	-3.61	-7.39	-4.21	0.68	-1.05
R^2	20.41	12.33	46.41	21.47	1.88	3.96

Panel C. Correlation coefficients with changes in the VIX

	FFR	*ED*	*FFR*	*ED*	*FFR*	*ED*
corr	-0.02	0.15	0.15	0.22	-0.23	0.09

Table IA.9: Response of Equity Returns & Flows to Monetary Policy Surprises: Variations

This table considers different event windows to estimate the response of equity returns and equity flows to monetary policy surprises (Table 2). Panel A provides results when we extend the event window from -15 minutes to the close on all days. Panel B reports results when we constrain the event window from -15 minutes to +45 minutes on all days (and ignore the information content of press conferences). T-statistics are based on bootstrap standard errors. Panel B and C account for the fact that the regressors are estimated.

Panel A. Wide event window (-15:close)

	Equity Returns						**Equity Flows**		
	Event Window Returns			Daily Returns			Daily Flows		
	SR	LR	RS	SR	LR	RS	SR	LR	RS
b	-0.16	-0.17	0.90	-0.24	-0.12	0.90	-0.14	-0.24	0.37
$t(b)$	-1.52	-1.56	15.62	-1.73	-0.87	8.68	-1.08	-2.04	3.43
R^2	2.23	2.46	71.78	2.99	0.81	42.63	1.31	4.17	9.59

Panel B. Tight event window (-15m:+45m), ignore press conferences

	Equity Returns						**Equity Flows**		
	Event Window Returns			Daily Returns			Daily Flows		
	SR	LR	RS	SR	LR	RS	SR	LR	RS
b	-0.04	-0.12	0.63	-0.21	-0.25	0.44	-0.14	-0.31	0.32
$t(b)$	-0.56	-1.62	12.84	-1.54	-1.80	3.32	-1.16	-2.72	2.65
R^2	0.30	2.87	74.81	2.39	3.17	10.22	1.40	6.91	6.92

Table IA.10: Discount Rate News: VAR Parameter Estimates

This table shows VAR parameter estimates (b) for a first-order VAR model including a constant, the daily S&P500 excess return ($Ret_t - Rf_t$), the option implied lower bound on the expected equity premium for a horizon of one month (EP_t), as in Martin (2017)), the variance risk premium (the difference between option implied variance and the expected realized variance, $VIX_t^2 - RV_t^2$, as in Bollerslev, Tauchen, and Zhou (2009); where we estimate the expected realized variance as in Corsi (2009)), and the dividend price ratio (provided by Datastream, "DSDY"). EP_t and $VIX_t^2 - RV_t^2$ are scaled such that they correspond to a daily frequency. We then apply the classic formulas (e.g., Campbell and Vuolteenaho (2004)) to compute "discount rate news" and the "cash-flow news" (="residual news"). This proxy of "discount rate news" is then used in Figure 5 as a dependent variable. The data are daily (close-close) and the sample period is from 2006 to August 2014.

	VAR Parameter Estimates			
	$Ret_{t+1} - Rf_{t+1}$	EP_{t+1}	$VIX_{t+1}^2 - RV_{t+1}^2$	DP_{t+1}
$b(Ret_t - Rf_t)$	-0.07	0.00	0.02	0.00
$b(EP_t)$	15.09	0.91	-4.66	-0.41
$b(VIX_t^2 - RV_t^2)$	0.66	0.00	0.74	-0.02
$b(DP_t)$	-0.22	0.00	0.07	1.00
$t(Ret_t - Rf_t)$	-2.58	0.82	5.06	2.23
$t(EP_t)$	2.54	31.96	-5.88	-2.40
$t(VIX_t^2 - RV_t^2)$	3.25	-3.05	26.60	-3.16
$t(DP_t)$	-0.80	2.15	2.54	128.43
F, pv	0.00	0.00	0.00	0.00
R^2, %	2.79	94.65	81.29	98.88
$Var(CF)$	27.71			
$Var(DR)$	31.38			
$Cov(DR, CF)$	-20.45			

Table IA.11: Absolute Risk Shifts and Market Commentary

We collect market commentary on scheduled FOMC announcement days from *Thomson Reuters Instant View.* We then count the frequency of words that relates to economic and financial conditions or the surprise content of the news divided by the total number of words, $F_{i,FOMC}$, and run the following regressions: $|Risk\ Shift_{t|FOMC}| = a + bF_{i,FOMC} + e_{t|FOMC}$, where $|Risk\ Shift_{t|FOMC}|$ is the absolute Risk Shift on a FOMC announcement day (see Table 1 for details). The sample period is from 2006 to 2017; 96 scheduled FOMC announcements.

	$\lvert Risk\ Shift_{t\|FOMC}\rvert = a + bF_{i,t\|FOMC} + e_{t\|FOMC}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation	-0.08								
t	[-1.58]								
Employment		-0.11							
t		[-1.68]							
Growth			-0.06						
t			[-0.96]						
Fin. Market				0.21					0.09
t				[1.86]					[1.28]
Risk					0.20				0.18
t					[2.48]				[2.71]
Surprise						0.15			0.05
t						[2.00]			[0.88]
Confidence							0.18		0.23
t							[2.13]		[2.84]
Disagreement								0.30	0.27
t								[2.55]	[2.84]
Constant	0.77	0.78	0.75	0.43	0.46	0.51	0.56	0.63	0.10
t	[8.03]	[7.72]	[7.02]	[3.37]	[5.55]	[5.91]	[6.62]	[9.77]	[0.72]
Observations	96	96	96	96	96	96	96	96	96
Adj. R^2	0.00	0.01	0.00	0.07	0.07	0.03	0.05	0.16	0.31

Table IA.12: Absolute Short Rate Surprises and Market Commentary

We collect market commentary on scheduled FOMC announcement days from *Thomson Reuters Instant View.* We then count the frequency of words that relates to economic and financial conditions or the surprise content of the news divided by the total number of words, $F_{i,FOMC}$, and run the following regressions:$|Short\ Rate_{t|FOMC}| = a + bF_{i,\ \mathrm{t|FOMC}} + e_{t|FOMC}$, where $|Short\ Rate_{t|FOMC}|$ is the absolute Short Rate Surprise on a FOMC announcement day (see Table 1 for details). The sample period is from 2006 to 2017; 96 scheduled FOMC announcements.

	$\|Short\ Rate_{t\|FOMC}\| = a + bF_{i,t\|FOMC} + e_{t\|FOMC}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation	0.04								
t	[0.65]								
Employment		-0.18							
t		[-3.18]							
Growth			0.01						
t			[0.17]						
Fin. Market				0.18					0.17
t				[1.93]					[1.67]
Risk					0.03				0.01
t					[0.37]				[0.09]
Surprise						0.04			-0.02
t						[0.54]			[-0.23]
Confidence							0.07		0.07
t							[0.93]		[0.99]
Disagreement								0.08	0.04
t								[0.84]	[0.59]
Constant	0.43	0.61	0.46	0.24	0.43	0.41	0.42	0.45	0.20
t	[4.43]	[5.35]	[5.05]	[2.69]	[3.77]	[3.17]	[6.19]	[5.93]	[1.55]
Observations	96	96	96	96	96	96	96	96	96
Adj. R^2	0.00	0.05	0.00	0.05	0.00	0.00	0.00	0.00	0.02

Table IA.13: Absolute Long Rate Surprises and Market Commentary

We collect market commentary on scheduled FOMC announcement days from *Thomson Reuters Instant View.* We then count the frequency of words that relates to economic and financial conditions or the surprise content of the news divided by the total number of words, $F_{i,FOMC}$, and run the following regressions:$|LongRate_{t|FOMC}| = a+bF_{i,\text{ t|FOMC}}+e_{t|FOMC}$, where $|LongRate_{t|FOMC}|$ is the absolute Long Rate Surprise on a FOMC announcement day (see Table 1 for details). The sample period is from 2006 to 2017; 96 scheduled FOMC announcements.

	$\|Long\ Rate_{t\|FOMC}\| = a + bF_{i,t\|FOMC} + e_{t\|FOMC}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation	-0.03								
t	[-0.56]								
Employment		-0.15							
t		[-2.57]							
Growth			-0.09						
t			[-1.99]						
Fin. Market				0.13					0.12
t				[1.42]					[1.38]
Risk					-0.02				-0.03
t					[-0.27]				[-0.44]
Surprise						0.07			0.02
t						[1.12]			[0.39]
Confidence							0.13		0.13
t							[2.13]		[2.03]
Disagreement								0.06	0.04
t								[0.58]	[0.49]
Constant	0.73	0.82	0.80	0.53	0.72	0.62	0.60	0.69	0.45
t	[6.17]	[7.69]	[7.52]	[4.87]	[6.08]	[6.98]	[8.30]	[9.53]	[3.08]
Observations	96	96	96	96	96	96	96	96	96
Adj. R^2	0.00	0.03	0.01	0.02	0.00	0.00	0.02	0.00	0.02

Table IA.14: Market Commentary Example: Confirmation and Surprise About Quantitative Easing

	13.09.2012 (QE3); Risk Shift: +2.4
Action:	Announcement of QE3
Market Comments:	JEFF SAVAGE, REGIONAL CHIEF INVESTMENT OFFICER FOR WELLS FARGO PRIVATE BANK IN PORTLAND, OREGON: "The markets are at a very different place at the start of QE3 versus QE2 and QE1 and it will just get harder to continue to push higher using this same tool again. So there is no question the markets are not disappointed but they are certainly not going to get propelled off of these numbers. A lot of folks were expecting even less (from the Fed). A number of people were looking at statistics beyond the jobs report that would have made it hard for the Fed to do anything here." BRAD BECHTEL, MANAGING DIRECTOR, FAROS TRADING, STAMFORD, CONNECTICUT: "We got QE3, though I think it's a little less than what the market was hoping for. I think markets will read this as a positive sign, so risk should rally. But I don't necessarily think we'll have raging euphoria for it. It's positive, but not extremely positive." TODD SCHOENBERGER, MANAGING PRINCIPAL AT THE BLACKBAY GROUP IN NEW YORK: "This is exactly what Wall Street and, quite frankly, Main Street wanted from the Fed today."
	19.06.2013 (taper tantrum); Risk Shift: -2.3
Action:	First meeting after taper tantrum (May 2013); Fed confirms the course
Market Comments:	COMMENTS: BRIAN LEVITT, SENIOR ECONOMIST AT OPPENHEIMERFUNDS IN NEW YORK, NY: "The Fed is obviously more optimistic than they had otherwise been about the US economy and I think it confirms a lot of the better economic conditions that we had been seeing too. "Certainly the Treasury market is telling us something. The Fed does not appear to be as worried about things as they had suggested in prior statements and that signals to the market that they are taking somewhat of a more hawkish tone. . . . " "Investors always freak out at what looks like a sea change in policy, but typically policy normalization and or tightening is coincident with improving macro conditions and a generally healthy environment for stocks." STEPHEN MASSOCCA, MANAGING DIRECTOR, WEDBUSH EQUITY MANAGEMENT LLC IN SAN FRANCISCO: "You would think everything he would be saying would be good for bonds, not bad for bonds. This started well before he started speaking. It's beyond me. I could see if the taper had begun. The only thing I could think of is that people were positioned to short the dollar and they used the proceeds from being short the dollar to be long bonds and somehow they see this is as being positive for the dollar. But none of this makes any sense - it's almost the opposite of what is expected." AXEL MERK, PRESIDENT AND CHIEF INVESTMENT OFFICER, MERK INVESTMENTS, PALO ALTO, CALIFORNIA: "The main news is that they do indeed plan to taper purchases later this year and hope to be done by next summer. Bernanke wants to communicate that this is not necessarily tightening, but the market may not see it that way. "

Table IA.15: Market Commentary Example: Confirmation and Surprise About the Exit

	28.01.2015 (rate hike hinted); Risk Shift: -1.1
Action:	Fed hints a rate hike later the year (keep low at the moment)
Market Comments:	BARRY HoAire, FIXED INCOME PORTFOLIO MANAGER AT LOS ANGELES BASED BEL AIR INVESTMENT ADVISORS: "The Federal Reserve kind of... maintained the pledge that they're going to be patient. That was big, because everybody has baked into the cake at least one interest rate hike this year. Some people thought maybe even two. Now they're still telling you they expect to give you an interest rate hike. It may not be as early as some people expect. They're still telling you they expect to give you a 25 basis point increase this year. There's probably a good chance that happens." BRUCE MCCAIN, CHIEF INVESTMENT STRATEGIST AT KEY PRIVATE BANK IN CLEVELAND, OHIO: "Given some recent economic statistics, the Fed feels there's a need to hold off on raising rates until mid-year or even later. No earlier than mid-year. Being "patient" means the Fed is in no hurry with respect to inflation or any other factor in the economy that it is watching. This isn't surprising at all; the Fed was always more patient than other observers. "I don't think markets will move too much on this. The bigger issue is where the economy goes from here, and investors have been sobering up on that, as it becomes clear that we're growing, but below historical levels."
	18.03.2015 (leave rates unchanged); Risk Shift: +2.7
Action:	Fed announces to keep rates low this year
Market Comments:	DAVID JOY, CHIEF MARKET STRATEGIST, AMERIPRISE FINANCIAL, BOSTON: "I applaud the Fed's actions today. By eliminating 'patient' from its guidance it removed an artificial stricture on its flexibility, creating room for the data to dictate its future actions. At the same time, by lowering its expectations for the pace at which rates will rise, it sent a clear signal that it is in no hurry to push rates higher as it views the economy as growing only moderately. Today's decision should be constructive for risk assets, and relieve some upward pressure on the dollar." DAN MORRIS, GLOBAL INVESTMENT STRATEGIST, TIAA-CREF, NEW YORK: "You're looking for something that isn't going to scare the horses, they've been clearly trying to signal as much as they can ahead of time what they're going to do, and tell you what they're going to do and then do what they said they were going to do. So the fact that they dropped 'patient' is what everyone expected. So that's a good thing. "Kudos in terms of the message you're getting out of the Fed, I think they've been doing that well, and that's important. Now what does it mean? This is where the market can play the schizophrenia thing. "The path that's going to play out slightly longer term is 'Yes, the economy is OK.' The biggest challenge for equities isn't per se the fact that rates are going up, I don't see that as a real barrier, the bottom line is valuations are high right now and that's a bigger concern." GARY THAYER, HEAD OF MACRO STRATEGY AT WELLS FARGO INVESTMENT INSTITUTE IN ST. LOUIS: "It's positive in the sense the Fed is not going to step on the brakes too hard here, that they are going to be cautious in their rate movements and I think that is appropriate."

Table IA.16: Monetary Policy Surprises and Equity Style Premia

	Fama-French Factors and Monetary Policy Surprises on FOMC Days					
$R_{t\|FOMC}$	**Mkt-Rf**	**SMB**	**HML**	**RMW**	**CMA**	**STR**
	Average Returns, FOMC Days vs All Days					
$mu_{All} \times 10000$	3.85	0.50	-0.07	1.35	0.22	3.01
$mu_{FOMC} \times 10000$	39.61	1.83	12.93	-6.94	-7.33	15.53
	$R_{t\|FOMC} = a + b_{SR}SR_{t\|FOMC} + b_{LR}LR_{t\|FOMC} + b_{RS}RS_{t\|FOMC} + \xi_{t\|FOMC}$					
$a \times 10000$	10.27	-1.47	6.14	-4.60	-2.47	-9.65
t	0.98	-0.21	0.80	-1.06	-0.63	-1.40
b_{SR}	-0.10	-0.08	-0.07	0.00	-0.05	-0.12
t	-0.42	-1.07	-1.03	-0.04	-1.06	-0.73
b_{LR}	0.14	-0.01	0.14	-0.06	-0.09	0.01
t	0.92	-0.12	1.50	-1.02	-1.64	0.04
b_{RS}	0.66	0.01	-0.06	0.04	-0.05	0.19
t	5.68	0.20	-0.83	1.04	-0.99	1.88
$R^2, \%$	30.24	1.03	6.52	2.96	5.53	8.76
	$R_{t\|FOMC} = a + b_{RA}RS_{t\|FOMC} + \xi_{t\|FOMC}$					
$a \times 10000$	13.28	-0.65	8.76	-5.28	-3.01	-8.24
t	1.24	-0.09	1.18	-1.19	-0.77	-1.19
b_{RS}	0.65	0.03	-0.08	0.05	-0.02	0.20
t	6.20	0.37	-1.33	1.32	-0.55	2.18
$R^2, \%$	27.93	0.15	1.71	1.56	0.40	7.16

Internet Appendix: Figures

Figure IA.1: Coverage of ETF Flow Data

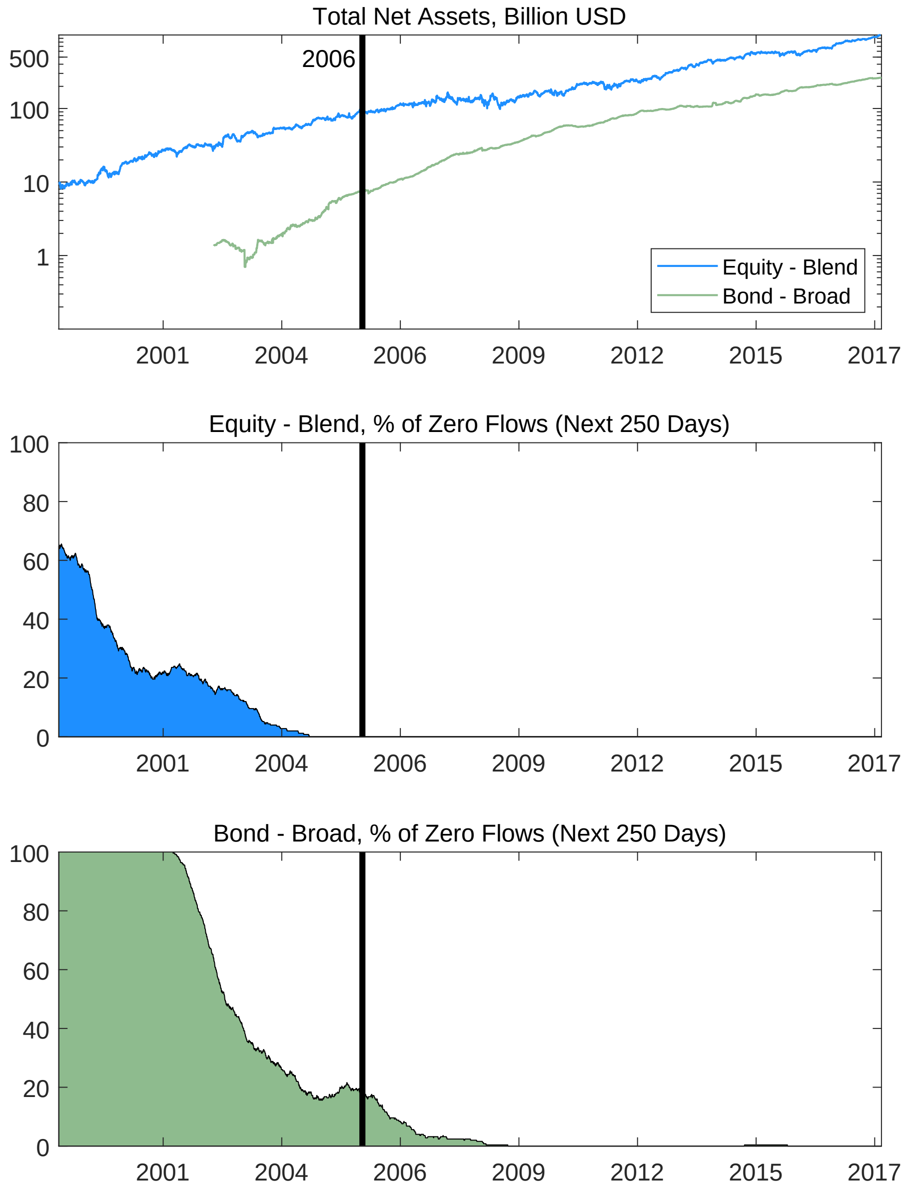


Figure IA.2: Short Rate Surprises on FOMC Announcement Days

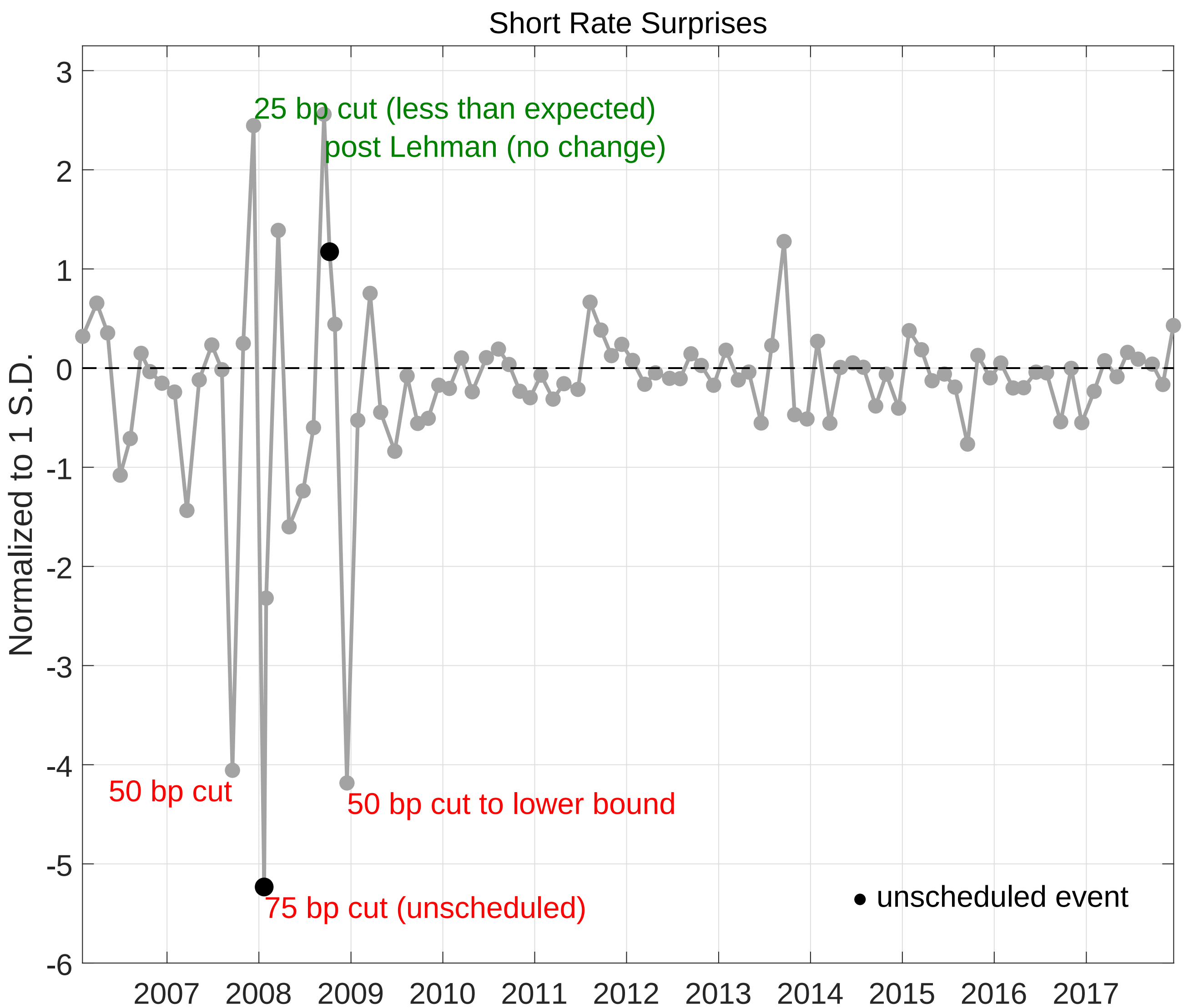


Figure IA.3: Long Rate Surprises on FOMC Announcement Days

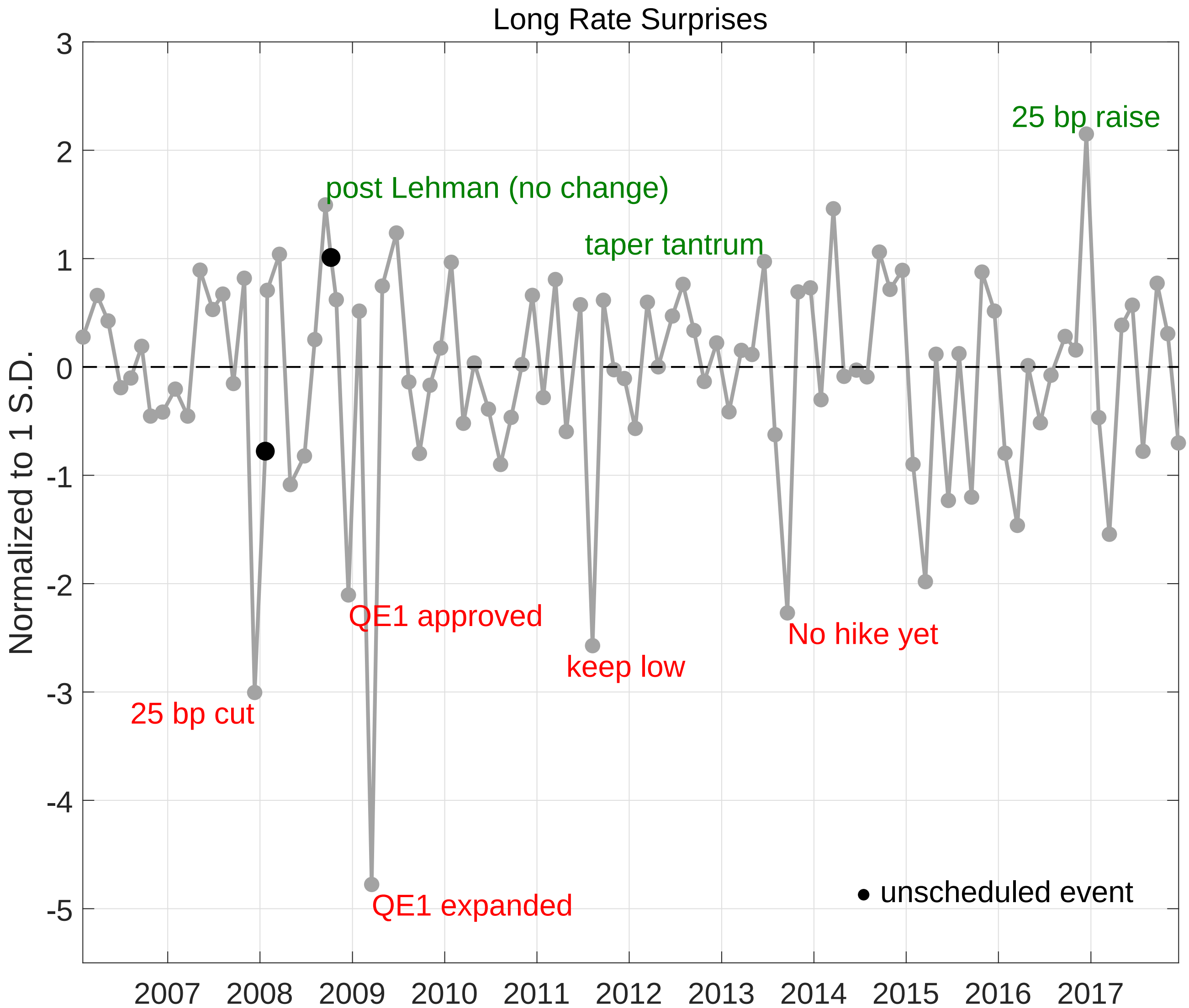


Figure IA.4: Stock Market Response to Short and Long Rate Surprises on FOMC Days

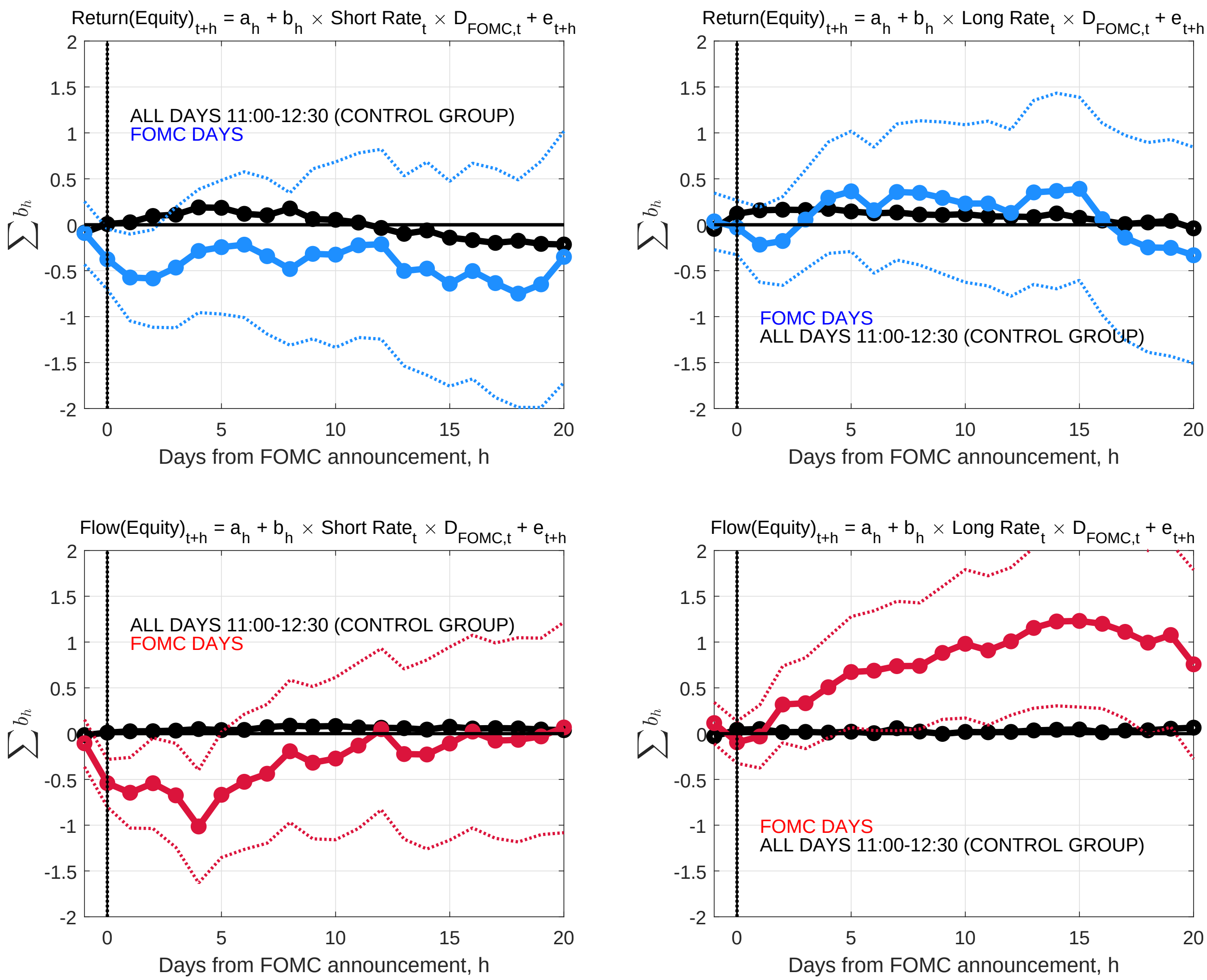
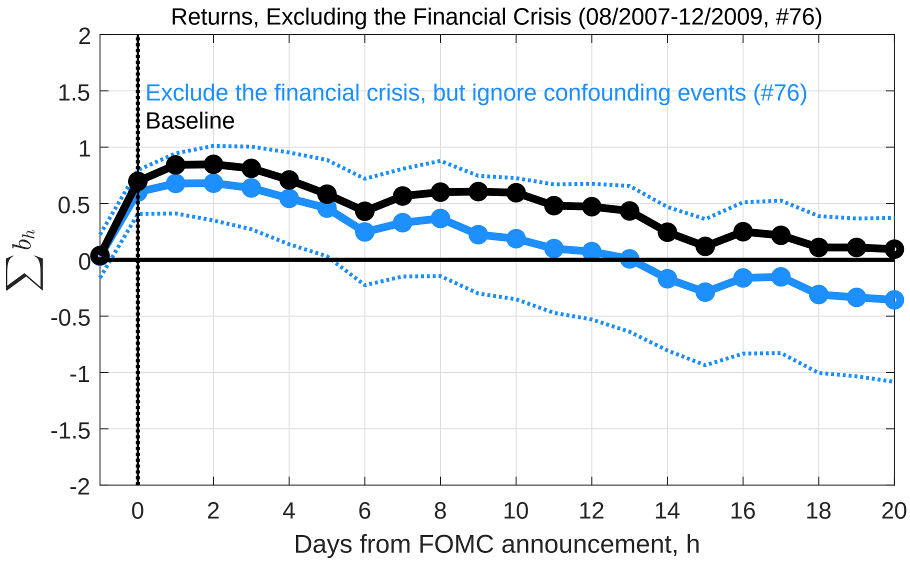


Figure IA.5: Excluding the Financial Crisis



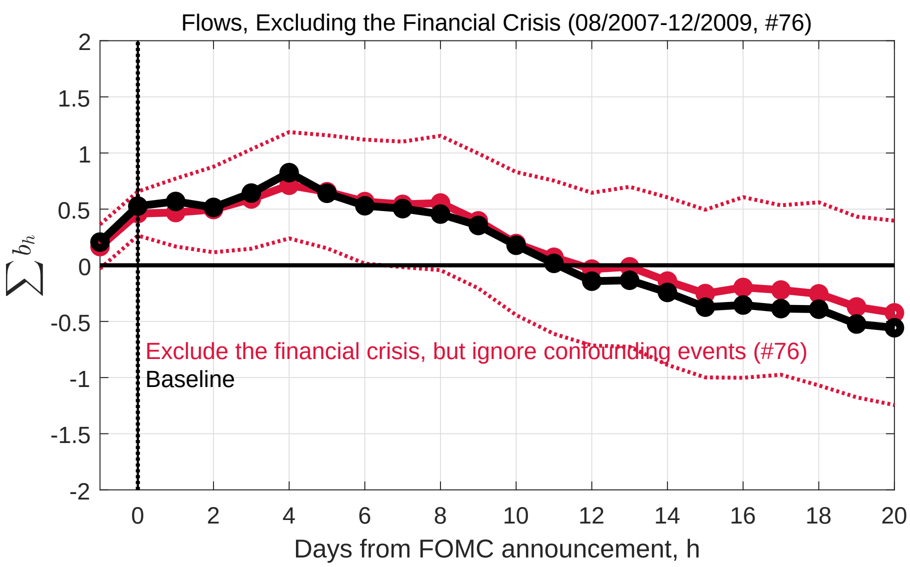


Figure IA.6: Exclude or Focus on Press Conferences

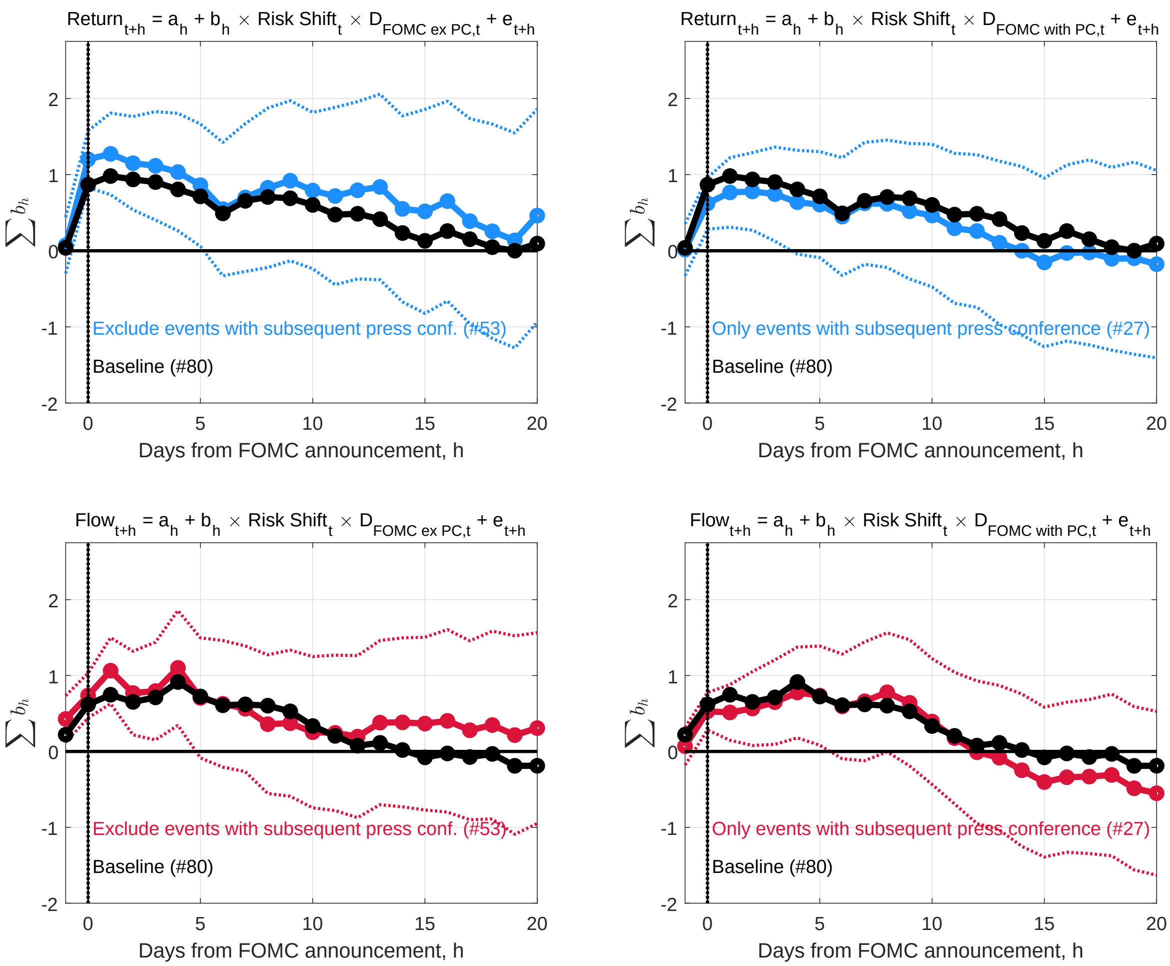
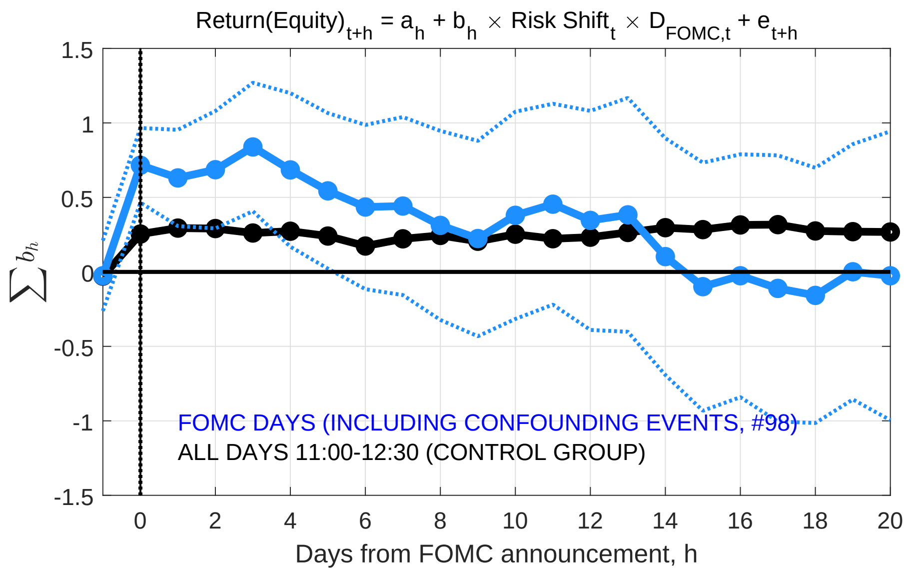


Figure IA.7: Include Confounding Events



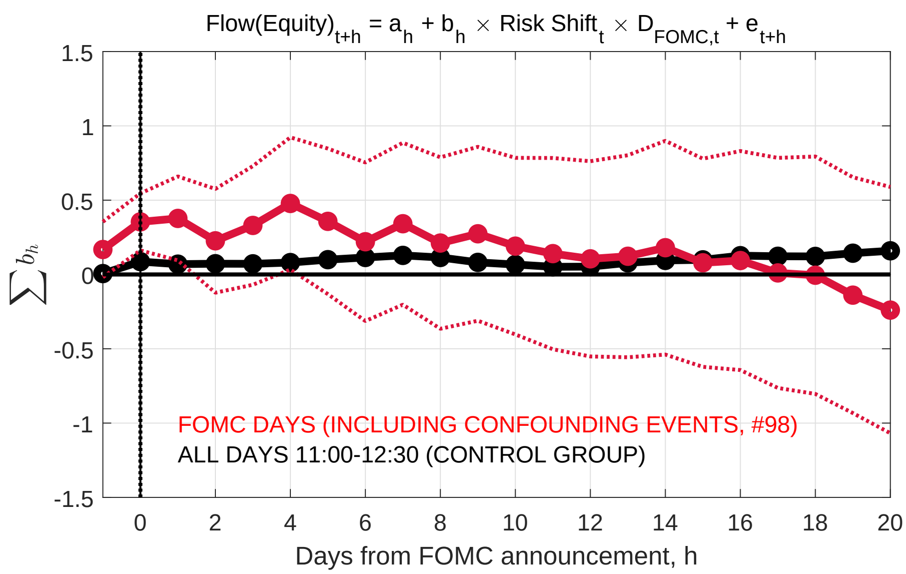


Figure IA.8: Alternative Risk Shift Factor: Regression-based Orthogonalisation of Risky Asset Prices

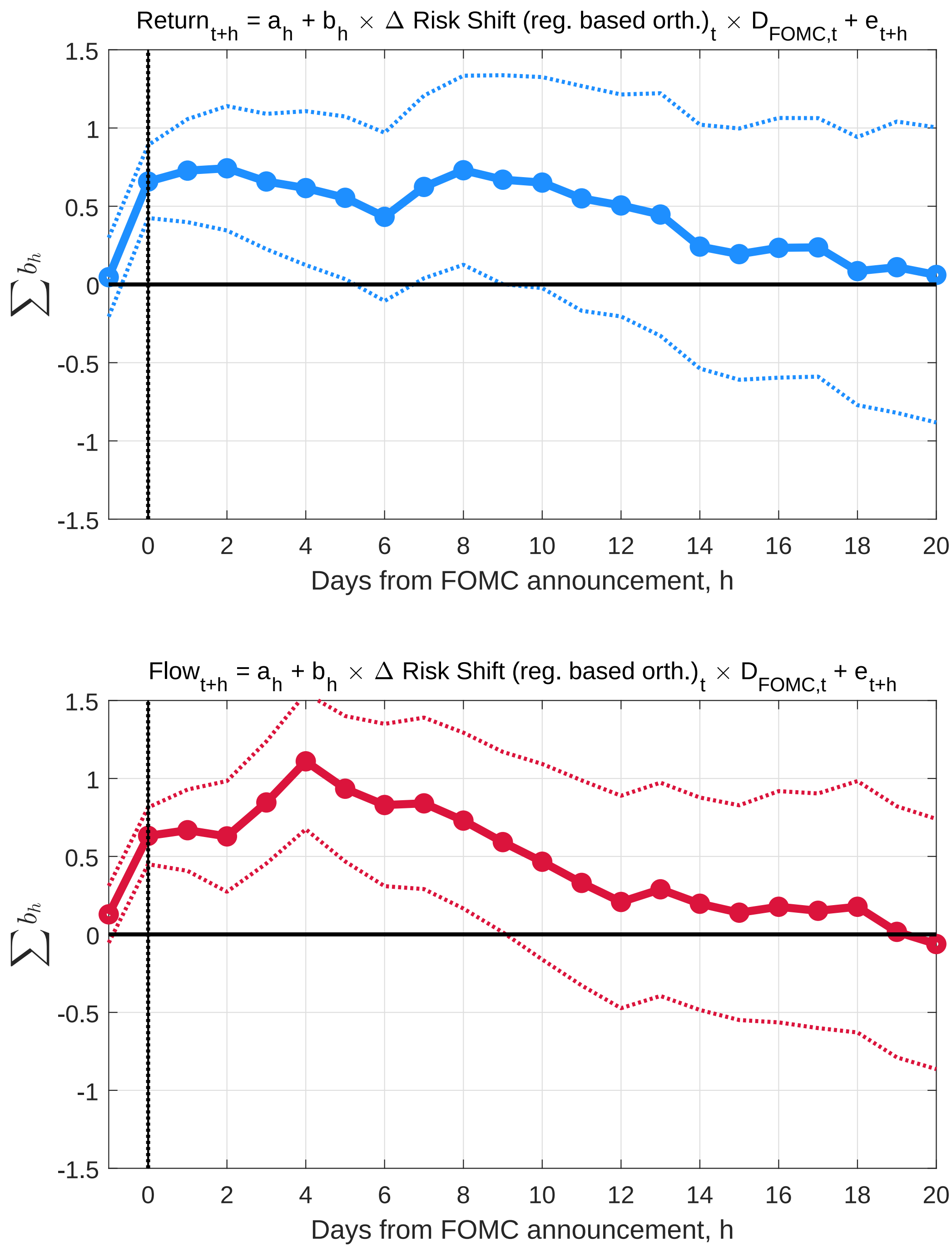


Figure IA.9: Macro Announcements

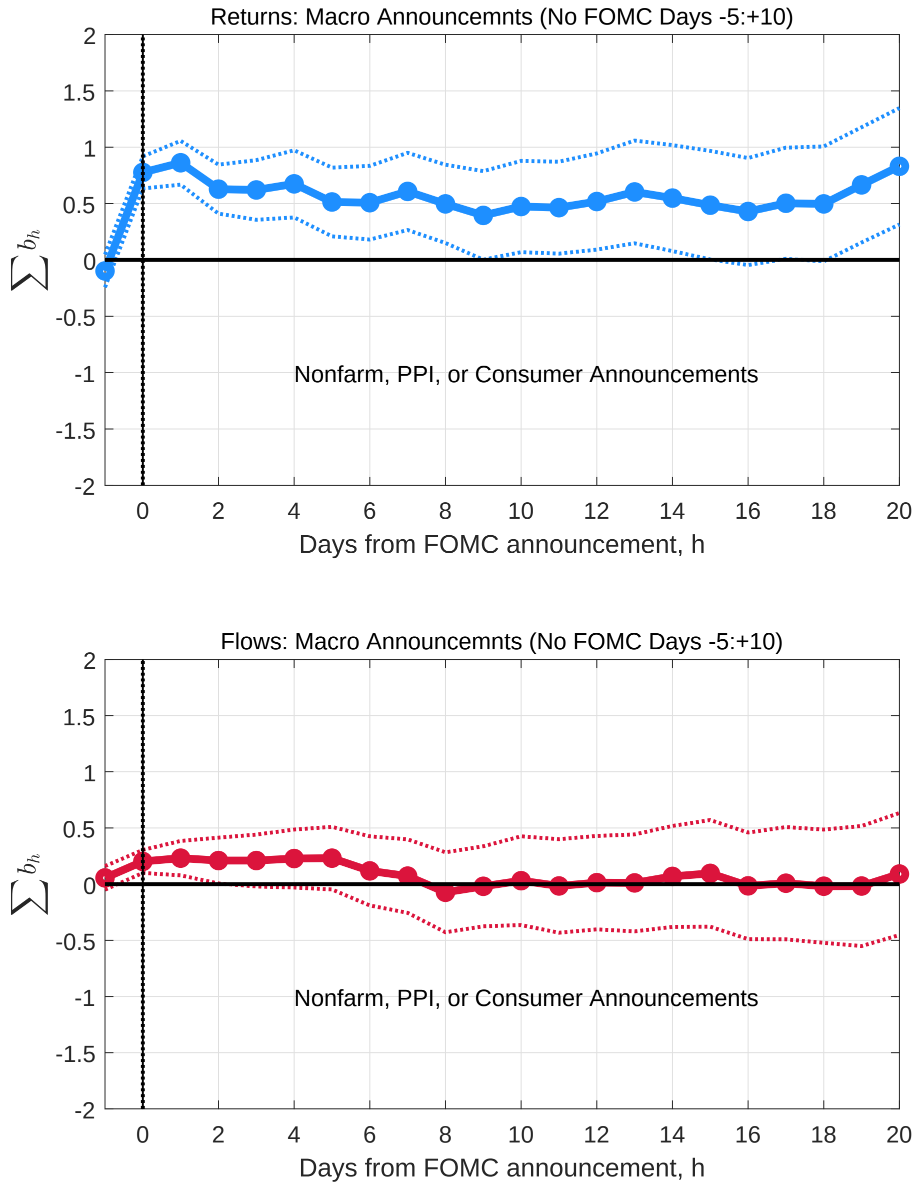
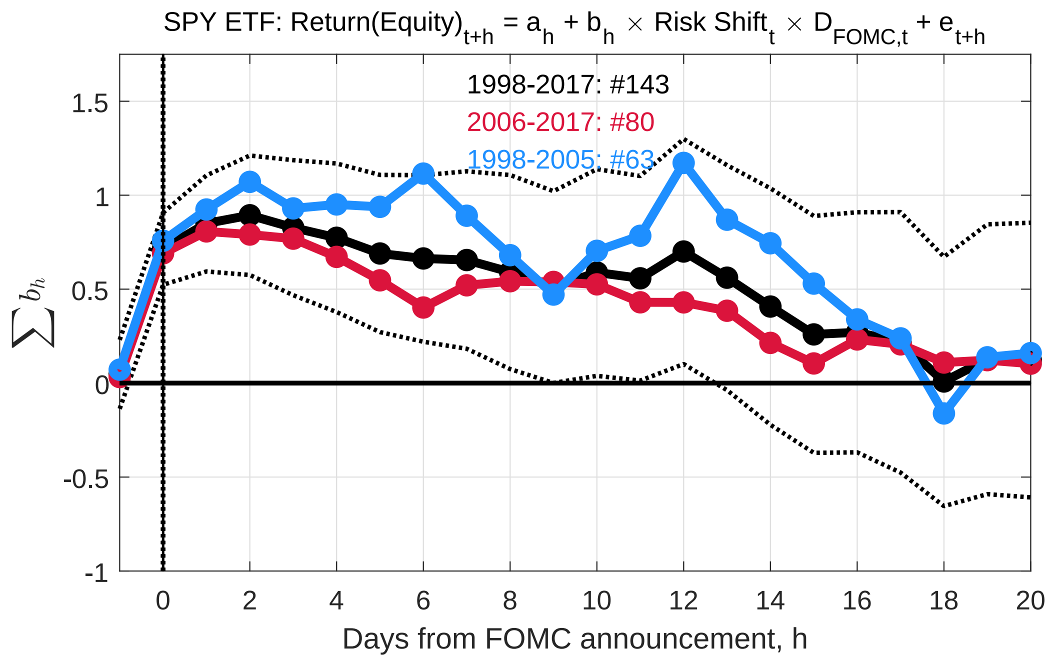


Figure IA.10: Long Sample Results



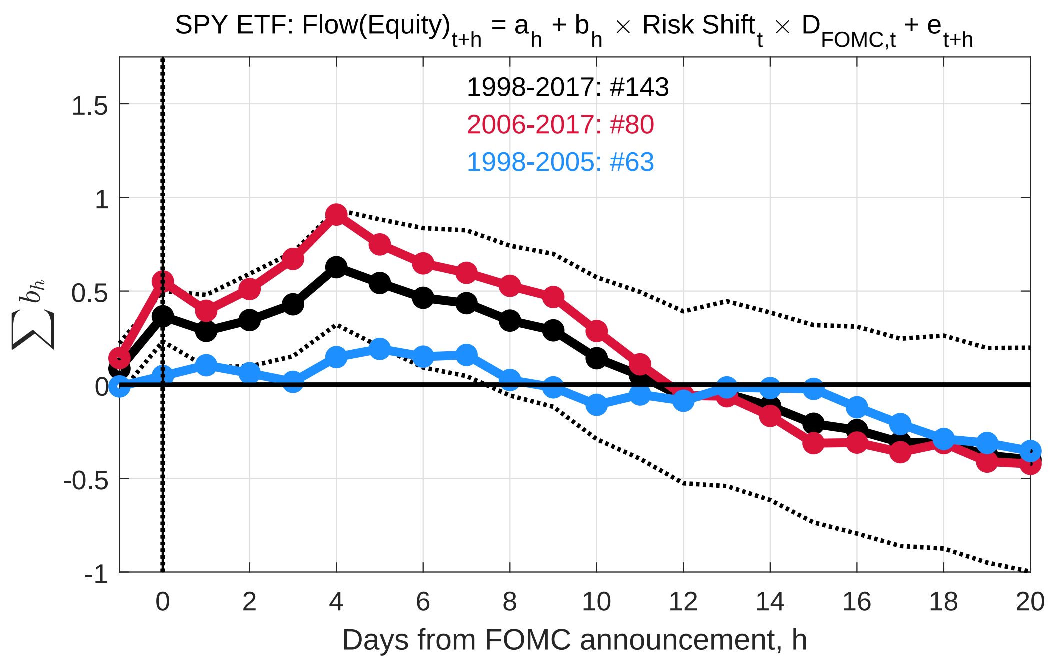


Figure IA.11: Mutual Funds

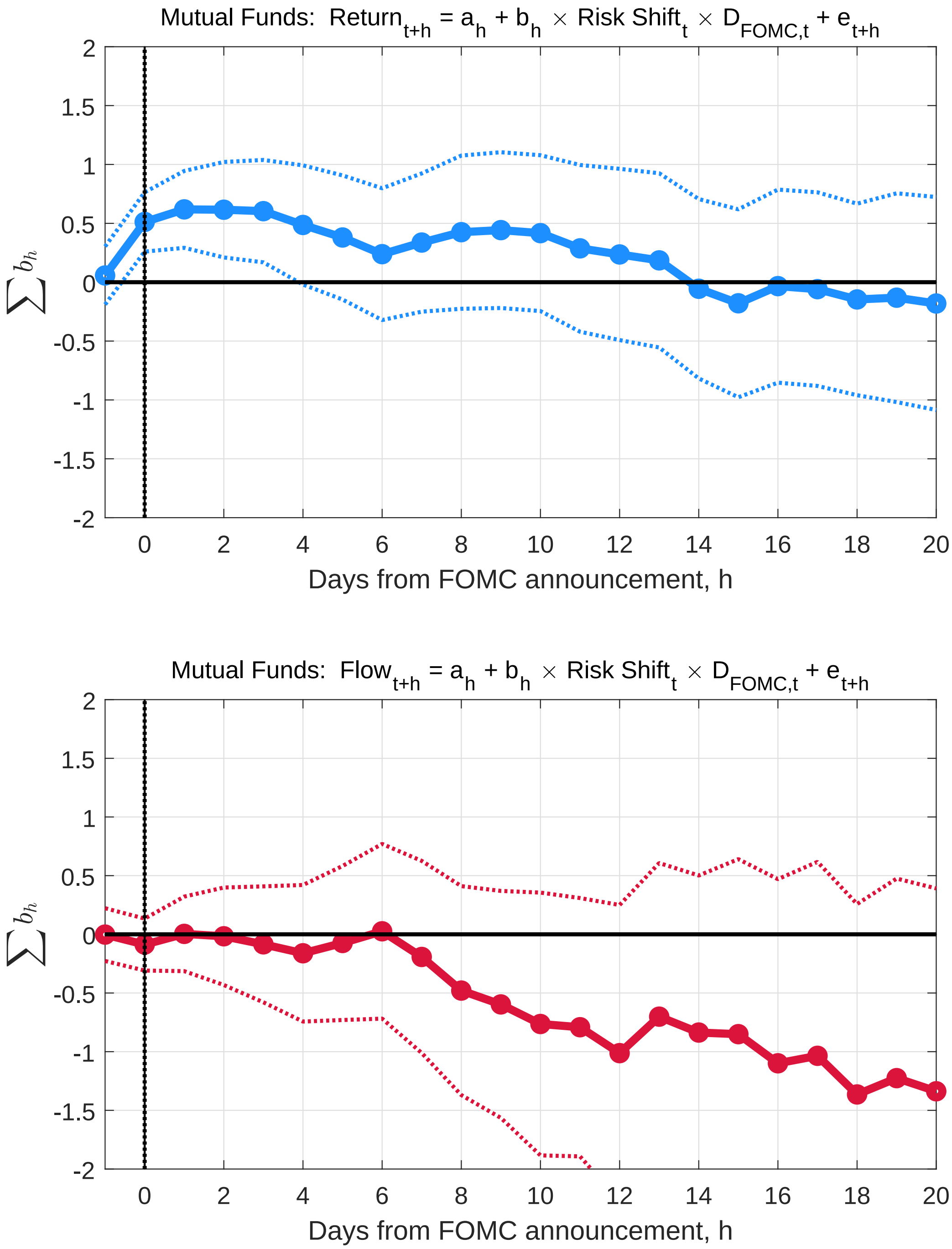


Figure IA.12: Outlier Analysis: S&P 500 Intraday Returns

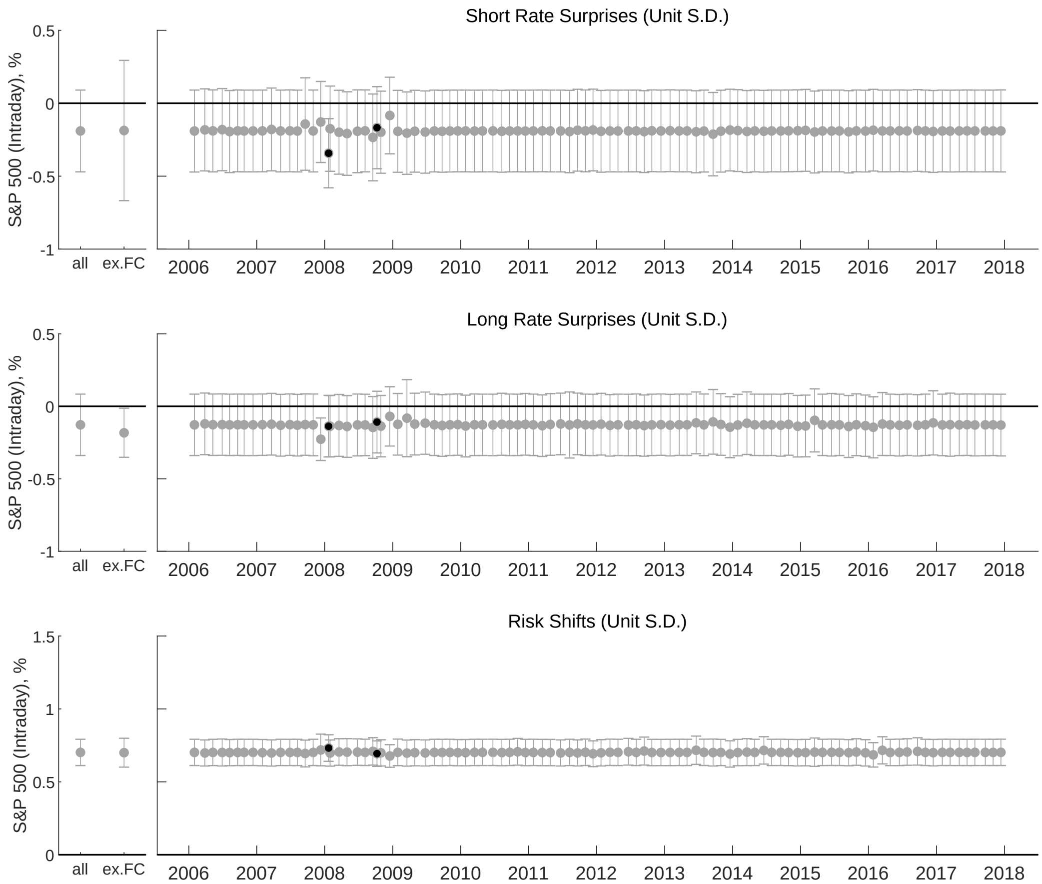


Figure IA.13: Outlier Analysis: Daily Fund Returns

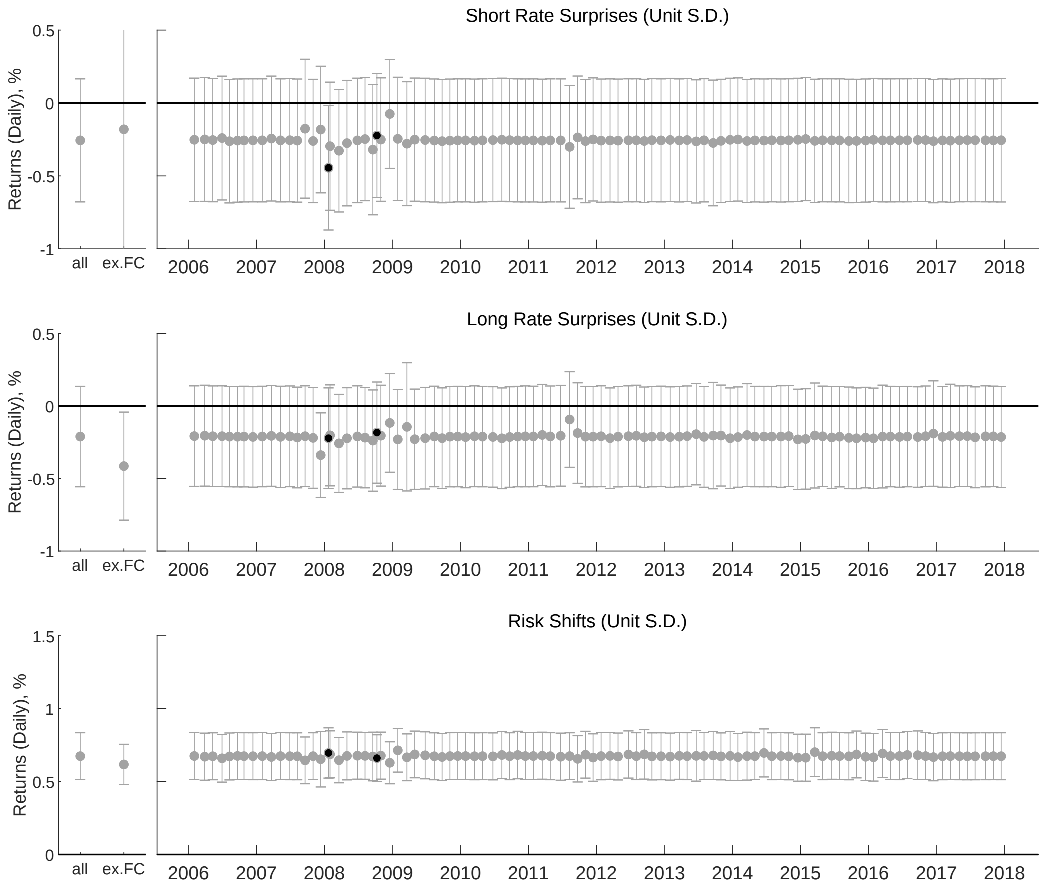


Figure IA.14: Outlier Analysis: Daily Fund Flows

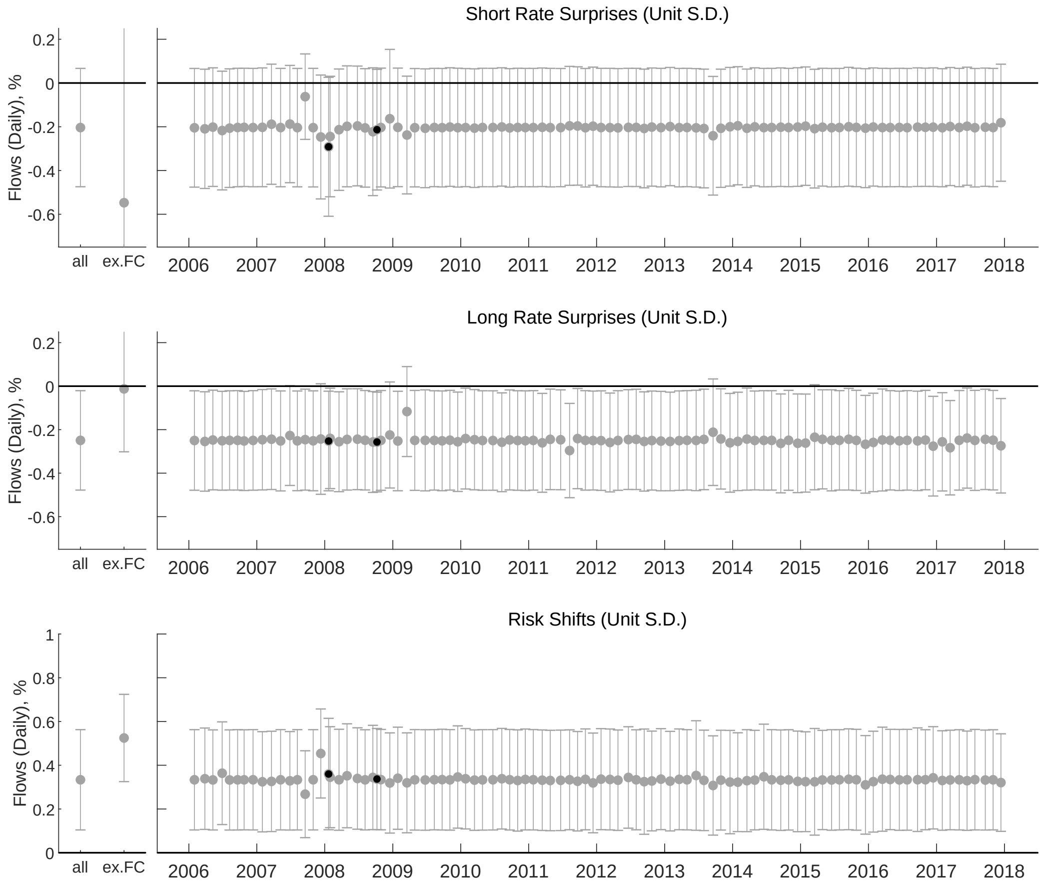


Figure IA.15: The FOMC Risk Shift Cycle