The FOMC Risk Shift*

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Abstract

This paper presents new evidence on channels through which monetary policy affects prices in equity and other asset markets. A large part of U.S. equity price moves around FOMC meetings can be attributed to shocks that are uncorrelated with yield changes but closely linked to changes in investors' risk appetite. These price effects are mirrored by investors' portfolio rebalancing decisions, manifesting themselves via sizeable shifts in fund flows between bonds and equities. All these effects are transitory and largely reversed after about one month. We find evidence that risk appetite shocks are related to changes in uncertainty triggered by FOMC meetings.

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I. Introduction

The link between monetary policy and asset prices is of key importance for market participants and policymakers alike. While central banks ultimately aim at affecting macro quantities such as real output and inflation, the most direct effect of changes in policy rates, and other forms of monetary policy, occurs in financial markets. And indeed, the transmission of monetary policy to macroeconomic quantities is widely thought to operate via asset prices, such that changes in the monetary policy stance will affect, e.g., consumers' borrowing costs, firms' cost of capital, intermediary net worth or the aggregate wealth of investors, in turn affecting consumption and investment decisions.

A long literature has studied how monetary policy affects equity prices. A common view is that equity prices move in response to new information about easing or tightening of monetary policy. Under this view information is transmitted through fixed income yields to stock prices such that monetary easing (tightening) increases stock prices because of higher future cash flows and/or lower risk premia. The seminal work by Bernanke and Kuttner (2005) as well as more recent evidence in, e.g., Bekaert, Hoerova, and Duca (2013a) suggest that risk premia play a prominent role in this transmission via yields. Our paper adds to this literature and provides a new perspective on monetary policy's role in affecting stock prices and other risky assets by documenting an additional (and complementary) channel which does not operate via yields. More specifically, we show that changes in investors' risk appetite, which are uncorrelated with short and long-term yield changes by construction, play a prominent role in explaining both stock returns and fund flows around monetary policy announcements.

Our *first* innovation is to infer different channels of transmission based on the reaction of a large set of asset prices around FOMC events, allowing us to better discriminate among different economic drivers. In this context, we build on the methodology put forth by Guerkaynak, Sack, and Swanson (2005) and Swanson (2017) and perform a factor analysis on a cross-section of yields to extract orthogonal asset price shocks on FOMC days. Similar to these papers, we use a cross-section of yields (from 3-months to 10-years) but we augment these yields with changes in a range of asset prices that are particularly sensitive to the repricing of risk: CDS spreads, a broad U.S. dollar index, VIX, as well the implied volatility of long-term government bonds (the TYVIX).

We find three factors to account for more than 90% of the overall variance of these key asset prices on FOMC days: (i) a shock to short-term rates up to 2-years, (ii) a shock to long-term rates (5 to 10 years), and (iii) a shock to risk appetite (foreign currency returns, CDS premia, VIX, and TYVIX). We label the third one 'risk appetite' to describe that these shocks load negatively on the market-based risk proxies. Since these factors are orthogonal by construction, they capture distinct components of monetary policy shocks. Most importantly, the third factor, risk appetite, is uncorrelated with the first two factors related to yields. Hence, we are able to disentangle shocks to risk appetite from shocks that move the term structure of safe interest rates. We rely on this information to study how different types of monetary policy shocks affect financial markets.

The *second* innovation is to study the joint response of prices *and* quantities around scheduled monetary policy events. We measure the latter via investor reallocation decisions (changes in ETF fund flows) around FOMC meetings at a daily frequency. ETFs are frequently used by institutional investors to obtain tactical exposure to certain asset classes, in particular at short horizons.[1] In this sense, ETF fund flows are a proxy for the demand of institutional investors or, more generally speaking, "fast money". Measuring the response of prices and quantities is key as it allows us to study which type of shocks specific investors respond to in terms of actual money flows rather than just inferring the impact of shocks from changes in observed asset prices.

Our first main result is that shocks to risk appetite are the main driver of the equity premium on FOMC days. A positive risk appetite shock is associated with a significantly positive return differential between equities and bonds. For example, a one-standard deviation risk appetite shock corresponds to a daily equity excess return of 0.82% (t-stat: 7.4) on an FOMC day. Interestingly, the price response to risk appetite shocks has a large transitory component and

[1] E.g., Ben-David, Franzoni, and Moussawi (2013), Balchunas (2016), Madhavan (2016).

a substantial part of the initial reaction of prices (0.82%) is reversed after about four weeks (0.14%).

By contrast, short and long rate monetary policy shocks do not significantly drive equity prices around FOMC meetings. Put differently, changes in short or long-term yields triggered by news about monetary policy account for almost none of the variation in equity returns.

Our second main result is that risk appetite shocks also move quantities and lead to sizeable reallocation shifts from bond ETFs to equity ETFs. For example, a one-standard deviation risk appetite shock corresponds to a reallocation from bonds to equities of 1.1% (relative to total assets) after an FOMC meeting. Moreover, quantities closely follow prices. A substantial part of the initial reaction of flows is reversed after about four weeks just as for stock prices.

We also find that these effects are not just limited to equities but carry over to other risky assets as well. Asset classes such as corporate credit, high-yield bonds, emerging market bonds, and emerging market equities all see significant inflows whenever there is a pick-up in risk appetite on FOMC meeting days.

How can these findings be interpreted? We use the standard vector autoregression (VAR) approach (Campbell and Shiller, 1988, Campbell, 1991) to decompose daily stock returns into discount rate news and a residual. The short-term return predictors that we consider in this decomposition are 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 lower bound in Martin, 2017). Based on this setup, we show that up to 50% of stock returns on FOMC days are driven by discount rate news. Moreover, we find that risk appetite shocks strongly co-move with innovations in the variance risk premium and the SVIX-based equity premium.

We provide evidence that the large shift in discount rates might stem from changes in uncertainty triggered by FOMC announcements. First, we show that most of the price reaction occurs *after* the FOMC announcement when new information hits the market. Second, our analysis of discount rate news on FOMC days shows that the variance risk premium as well as the lower bound on the equity premium implied by option prices moves in opposite direction of returns and risk appetite shocks. From a theoretical perspective, these empirical patterns are qualitatively in line with models where investors are sensitive to changes in uncertainty, e.g. Bollerslev, Tauchen, and Zhou (2009). Third, we employ textual analysis of market commentary and show that risk appetite shocks tend to be larger when market participants state that the announcement was "unpredictable", "confusing", or "vague" or when the term "uncertainty" itself is mentioned more frequently.

The other side of our finding is that stock prices seem to move "too much" relative to what can be justified by shifts in expected returns alone. Depending on the VAR specification, up to 50% of the initial return reaction can be explained by discount rate news as discussed above. The other 50%, i.e., the residual, is highly transitory and largely reversed within one week. The transitory nature speaks against the standard interpretation that the residual captures cash-flow news.

A more plausible explanation in our context is that the part of the return reaction unrelated to discount rate shocks is due to temporary price pressure.[2] In line with this price pressure interpretation, we find that risk appetite shocks forecast higher returns to liquidity provision (Nagel, 2012) on the day of and after FOMC meetings. In addition, we find that the flow reaction after risk appetite shocks is concentrated in the largest ETFs that are more liquid and known to be the most popular among large institutional investors (e.g., Balchunas, 2016).

In sum, we argue that stock returns around FOMC days are to a large extent driven by shocks to expected returns that are orthogonal to yields and that transitory price pressure accounts for another large portion of overall returns.

Related literature. There is a growing literature on the link between different dimensions of monetary policy and asset prices, following the seminal work by Bernanke and Kuttner (2005).[3] Several recent papers have studied how monetary policy (surprises) might affect risk premia,

[2] See also Bernanke and Kuttner (2005) on the idea that monetary policy news might generate price pressure in equity markets.

[3] Prior work includes Shiller, Campbell, and Schoenholtz (1983).

e.g., Adrian and Shin (2010), Borio and Zhu (2012), Bekaert, Hoerova, and Duca (2013b), Morris and Shin (2014), Hanson and Stein (2015), Gertler and Karadi (2015), Hattori, Schrimpf, and Sushko (2015), Schmeling and Wagner (2016), Leombroni, Vedolin, Venter, and Whelan (2016), Adrian and Liang (2016), Neuhierl and Weber (2016), Ozdagli and Weber (2016), Boyarchenko, Haddad, and Plosser (2017), Drechsler, Savov, and Schnabl (2017) or Malamud and Schrimpf (2017).

All these papers suggest that monetary policy affects equity prices. The key point in our paper is that we are focusing on monetary policy shocks that are unrelated to yield changes by construction. Thus, we do not rely on any indirect channels where higher or lower yields indirectly move (effective) risk aversion, e.g., by affecting intermediary net worth. Moreover, different from our study, these papers do not investigate the joint response of prices and quantities, the nature of monetary policy shocks, or shed light on the role of specific investor demands that might lead to price pressure effects.

A recent stream of the literature looks at average returns on FOMC announcement days. Savor and Wilson (2013) find significant average US excess stock returns on macroeconomic announcement days, including scheduled FOMC days. Lucca and Moench (2015) find evidence of a price drift ahead of FOMC announcements. They further find that basically the entire U.S. 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. Cieslak, Morse, and Vissing-Jorgensen (2016) detect a cycle in equity returns following the FOMC meeting schedule.

We complement this literature by documenting high average risk appetite shocks on FOMC announcement days that go hand in hand with a lower variance risk premium and a drop in the lower bound on the equity premium implied by option prices. Also we focus on the variation of returns (i.e., the news component of FOMC announcements), taken together, our results suggest that FOMC announcements are *on average* days with resolution of uncertainty.

We believe that these findings are helpful for developing new – and for discriminating between alternative – theoretical explanations of FOMC announcement returns. For example, Ai and Bansal (2016) show that a model in which investors are compensated for uncertainty aversion can generate high average announcement returns. Their empirical analysis, however, does not connect measures of uncertainty to FOMC returns. Our results also provide evidence for the idea that different investors react differently to FOMC news. This opens the door for models that incorporate heterogenous agents. For example, Bogousslavsky (2017) shows that infrequent rebalancing by some investors can generate substantial seasonality in asset returns. In his model, rebalancing is purely exogenous. A model where rebalancing is triggered endogenously by changes in uncertainty around FOMC meetings might also be in line with the seasonality pattern of FOMC returns and the response of quantities documented in our paper.

Our paper is also related to a recent literature using investor fund flows to gauge investor expectations and preferences, e.g., Greenwood and Shleifer (2014), and Berk and van Binsbergen (2016). Several papers analyze the interaction of fund flows and subsequent returns, and find evidence for flow-induced price pressure. Ben-Rephael, Kandel, and Wohl (2012) investigate monthly shifts from U.S. bond mutual funds to U.S. equity mutual funds. Jotikasthira, Lundblad, and Ramadorai (2012) document evidence for emerging markets. Our results suggest that price pressure from fund flows plays an important role in understanding the response of equity returns around FOMC meetings.

II. Monetary policy shocks

We extract orthogonal shocks related to monetary policy news on FOMC announcement days by means of a factor analysis as in Guerkaynak, Sack, and Swanson (2005) and Swanson (2017). Similar to Swanson (2017), we include changes of 3- and 6-months OIS rates, as well as 2-, 5- and 10-year Treasury yields. We do not include overnight (or 1-month) interest rates or Fed Funds surprises (e.g. Bernanke and Kuttner, 2005) since ultra short-term interest rates are trapped by the effective lower bound for most of our sample period.

We extend this set of yields with a number of additional asset prices from other asset classes (see, e.g., Boguth, Gregoire, and Martineau, 2016; Fernandez-Perez, Frijns, and Tourani-Rad, 2017; Mueller, Tahbaz-Salehi, and Vedolin, 2017, for related papers). In particular, we add changes in CDS spreads for a broad basket of industries, changes in the value of a broad U.S. dollar index (for which a higher reading means an appreciation of US dollars), changes in the VIX, as well as changes in the implied volatility of long-term government bond yields (TYVIX) to the analysis. These four variables 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. In addition, these four variables are sensitive to changes in risk and/or the pricing of risk, which is what we intend to capture in the subsequent analysis. We use log changes of the four risky asset prices to reduce the impact of heteroscedasticity and standardize all nine variables based on their full sample standard deviation. We then run a principal component analysis with all 80 scheduled FOMC announcement day observations.[4] Our baseline sample ranges from January 2006 to December 2015. This period allows us to study the reactions of prices (returns) and quantities (fund flows) to monetary policy shocks for equities and bonds.[5] Further details on data sources are provided in the caption of Table 1.

>>> TABLE 1 ABOUT HERE <<<

The left hand side of Table 1 shows that the first three principal components explain more than 90% of the variances of the nine variables. The three principal components are purely determined by how much variance they explain, but are not necessarily meaningful or easy to interpret economically. To obtain monetary policy shocks that are easier to interpret economically, we follow Swanson (2017) and apply an orthogonal factor rotation on the first three principal components. The first shock targets the front-end of the yield curve. It captures interest rate reactions due to changes in policy rates and their expected future path. The second

[4]Notice that the variance, conditional on the FOMC event day, can differ between the nine variables. In other words, we allow monetary policy shocks to have a larger impact on some variables compared to other variables. The variances of the variables, conditional on the day being an FOMC event, can be inspected at the right hand side of Table 1.

[5]In Section VI, we obtain similar results for a sample that is extended to 1996, or focuses on the period from 1996 to 2005.

shock targets the remaining long-term yields and thus is likely to capture potential effects of quantitative easing that may operate by affecting term premia embedded in long-term rates. The third shock targets the market-based risk proxies.

The loadings of the rotated monetary policy shocks are reported as “orthogonal rotation” on the right hand side in Table 1. Based on the loading patterns, we classify the three shocks as follows:

1. “*Short Rate Shocks*”: The first factor primarily loads on 3-month, 6-month, and 2-year yields and has very low loadings on all other variables;

2. “*Long Rate Shocks*”: The second loads on 2-year, 5-year, and 10-year yields. While it has basically no exposure to short-term yields, it it is mildly exposed to the market-based risk proxies. However, these exposures are smaller in magnitude and also differ in their sign (negative for CDS spreads and VIX, but positive for the U.S. dollar);

3. “*Risk Appetite Shocks*”: The third loads consistently negatively on all four market-based risk proxies. It hardly loads on the yield variables, though.

To be clear, the labels we assign to the monetary policy shocks are purely descriptive and simply indicate which asset prices the shocks load on. We shed light on the possible economic mechanisms that drive these monetary policy shocks in Section V of the paper.

We first plot the realizations of these three shocks (standardized to a unit standard deviation) in event time for the 80 FOMC announcements in our sample in Figures 1 to 3.

>>> FIGURE 1 ABOUT HERE <<<

>>> FIGURE 2 ABOUT HERE <<<

>>> FIGURE 3 ABOUT HERE <<<

Our monetary policy shocks indeed summarize important decisions along three key dimensions: *Short Rate* shocks trace surprises in the Fed's policy rate and medium-term expectations thereof, in particular in the period from 2006 to 2009 (Figure 1). Similarly, *Long Rate* shocks exhibit large swings that can be easily attributed to the monetary policy events that have a greater bearing on the longer-end of the yield curve (Figure 2). For instance, it increases when the Federal Reserve cut rates less than expected in the beginning of 2008, and it shows a series of highly negative readings in the beginning of 2009, due to various QE1-related announcements. Finally, *Risk Appetite* shocks (Figure 3) are highly positive on key announcements related to the introduction of QE1, QE2, and QE3. We observe a negative realization on the announcement of Operation Twist, which was largely perceived as a disappointment by market participants. Likewise, risk appetite also drops when the Federal Reserve communicated its intent to taper its asset purchases.

It is particularly interesting that certain types of monetary policy events are associated by a large reaction in risk appetite, whereas the response of yields as depicted in Figures 1 and 2 tends to be more muted. In sum, our finding is *not* that risk appetite shocks are independent of monetary policy. To the contrary, large realizations of our risk appetite shocks are clearly linked to important (unconventional) monetary policy decisions as well as both easing and tightening episodes. But, the risk appetite shocks we identify are uncorrelated with movements in the short and long end of the yield curve by construction and thus pick up a different dimension of monetary policy news. It is particularly this element of policy news that we are mostly interested in.

III. Gauging revealed preferences

A. Measuring quantities

Besides measuring the reaction of asset *prices* to monetary policy shocks, another key feature of our analysis is to measure how *quantities* are driven by monetary policy. Greenwood and Shleifer

(2014) show empirically that fund flows are related to investor expectations about future returns. Berk and van Binsbergen (2016) argue that if expected returns are misaligned with investors' preferences, an investment opportunity exists to which investors will react with corresponding fund flows. In our context, studying the response of quantities to monetary policy shocks serves to check whether changes in risk appetite do in fact lead to corresponding actions by market participants. If we observe non-zero flows, this implies that one subgroup of investors buys or sells from another subgroup of investors. Accordingly, investors must differ in their sensitivity towards this specific type of news and flows help to detect this heterogeneity. Thus, flows can give rise to important price pressure effects (e.g., Jotikasthira, Lundblad, and Ramadorai, 2012). These could at least partially help us understand the response of market prices to monetary policy shocks.

We use ETF fund flows to measure how investors increase or decrease their exposure to the stock or bond market in response to monetary policy shocks. ETF and mutual fund flows are to our knowledge the only investor flow data available at the daily frequency for stocks *and* bonds, 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 (2016) and Lettau and Madhavan (2016), 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.[6]

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

[6] 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 (2013) provide direct empirical evidence for institutional investors using ETFs for tactical asset allocation decisions.

are thus likely to be less responsive to news.[7]

B. Data

We collect daily ETF (and mutual fund) data from TrimTabs. We aggregate individual funds to asset classes. Our measure for U.S. equity is based on all funds that belong to Morningstar's category "Blend". Our measure for U.S. bonds is based on all funds belonging to the Morningstar categories U.S. "government", or investment grade "bond". Fund flows at the asset class level are measured as:

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

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 apply a normalization of flows. We rescale all flows to a 1% standard deviation using a backward 250-days rolling window.

Absolute flows in one particular asset class are difficult to interpret economically. For example, an inflow in one asset class might go hand in hand with inflows in all other asset classes, thus, simply reflecting a wealth shock (Curcuru, Thomas, Warnock, and Wongswan, 2011). For that reason, we construct a flow-based "risk shift" factor by simply subtracting bond flows from equity flows.[8]

From a portfolio perspective, investors' asset allocation can change i) due to an active trading decision, or ii) due to changes in relative prices of the securities held. Our risk shift factor captures the active change in the asset allocation. A positive "risk shift" number means that fund investors *actively* shift their asset allocation towards risky equities at the cost of safe bonds.

[7] Empirical evidence is provided by, e.g., Barber, Odean, and Zheng (2005), Frazzini and Lamont (2008).

[8] Ben-Rephael, Kandel, and Wohl (2012) also investigate a flow-based factor, which is monthly equity mutual fund flow minus bond mutual fund flow.

This ensures neutrality with regard to wealth effects.

For our baseline results, 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 (1) is exactly satisfied and we capture the total change of investors' exposure to asset class i. We complement our results obtained from fund returns with results based on S&P500 index future returns (available from the Chicago Mercantile Exchange), the CRSP market return and other equity factor returns based on the CRSP data (from the website of Kenneth R. French). Our baseline results employ a sample that starts in January 2006 and ends in December 2015 (2,516 daily observations). The starting year 2006 ensures that we observe an equity flow at every single day and a bond flow on almost all days (at 97% of the observed days). Later in the paper, we also provide robustness based on a longer sample period starting in 1996 (using less detailed flow data). Further details on the data and data coverage over time is provided in the Internet Appendix.

IV. The FOMC risk shift

In this section, we first document stylized facts about asset returns and our monetary policy shocks on FOMC meeting days. We then show how U.S. equity and bond prices respond to monetary policy shocks on FOMC days. Subsequently, we study the permanent and transitory effects of monetary policy shocks on asset prices as well as quantities (fund flows). We then provide additional evidence based on other risky asset classes, such as corporate bonds, high yield bonds, and emerging market bonds and equities.

A. *Mean returns and monetary policy shocks on FOMC days*

We start off by reporting average returns and average monetary policy shocks for daily observations on 80 scheduled FOMC announcement days for our sample period from 2006 to 2015. Table 2 provides results for a portfolio that is long in equities and short in bonds, as well as our three monetary policy shocks.[9] We report benchmark results for returns to stocks minus bonds (instead of a short-term risk-free rate) to make our evidence on prices consistent with our evidence on quantities. We will still refer to these returns simply as "excess returns".

>>> TABLE 2 ABOUT HERE <<<

We find positive and economically large average excess return on FOMC days in our sample, as reported in the recent literature. Equities significantly outperform bonds by 0.47% (t: 2.76) on a daily basis which cumulates to about 4% for 8 scheduled FOMC announcements per year. The ratio of positive to negative observations (#pos:#neg) is highly skewed towards positive FOMC returns (59:29).

Next, we want to understand the link between excess returns and our monetary policy shocks. Table 2 shows that *Short Rate* and *Long Rate* shocks are not significantly different from zero on average across the 80 scheduled announcement. Short Rate shocks are almost evenly split between positive and negative values, Long Rate shocks are somewhat skewed toward more *positive* realizations on FOMC announcement days (47:33).

In contrast, risk appetite shocks closely mirror the pattern for average returns. The average risk appetite shock is 0.59%, with a t-statistic of 3.1. Monetary policy shocks are normalized to a unit standard deviation over all days between 2006 and 2015, which suggests economically large average risk appetite shocks on FOMC days, in line with positive and high equity returns on these days.[10] This pattern in average excess returns and risk appetite shocks suggests that there might be a risk-based explanation of FOMC day returns.

[9] For the baseline results we rely on ETF fund returns (and flows). Our measure for U.S. equity is based on all funds that belong to Morningstar's category "Blend". Our measure for U.S. bonds is based on all funds belonging to the Morningstar categories U.S. "government", or investment grade "bond". Details are provided in the data Section of the paper and in the Internet Appendix.

[10] Note that the unconditionally positive average risk appetite shock does not conform well with the standard notion of a "shock" or "surprise". It is unclear whether investors could have learned about the on average positive changes in the instruments underlying our risk appetite shock measure or not. In any case, in a slight abuse of notation, we will still refer to our proxy for risk appetite changes as "shocks" for ease of notation.

B. *Benchmark time-series regressions*

We next turn to the time-series relationship between excess returns and monetary policy shocks. Table 3 shows results of regressions of equity excess returns on our monetary policy shocks on FOMC announcement days. Returns do not significantly respond to changes in the two monetary policy shocks derived from changes in yields. The regressions R^2 for these two shocks are well below 5%, so it seems fair to conclude that changes in yields do not account for the variation of equity excess returns on FOMC days. Put differently, FOMC day returns must react to news that are unrelated to the news reflected in yield changes.

>>> TABLE 3 ABOUT HERE <<<

In sharp contrast, stock excess returns are highly sensitive to risk appetite shocks that are orthogonal to changes in yields. A one standard deviation risk appetite shock goes hand in hand with an outperformance of equities over bonds of 0.82%, which is highly significant (t: 7.4). The regression intercept is zero, i.e. FOMC returns are zero when there is no news related to our measure of risk appetite. The large R^2 of 45% shows that risk appetite shocks carry important news for stocks markets or, equivalently, that the same factors that move the instruments underlying our risk appetite shock measure also move equity prices.

C. *Permanent and transitory effects of monetary policy shocks*

Having established a close link between excess returns and risk appetite shocks, we next turn to quantifying the permanent and transitory effects of our the three monetary policy shocks on FOMC announcement days, both for asset prices and quantities (fund flows).

We use a method akin to the local linear projection proposed in Jorda (2005) to do so. In the spirit of an event study, we estimate the effect of monetary policy shock on FOMC days as well as the cumulative effect over the following one to 20 days. More specifically, we run the following regressions:

$$X_{i,t+h} = a + b_h \times MP\ Shock_{j,t} \times D_{FOMC,t} + \xi_{i,t},$$

where $X_{i,t+h}$ is either the market excess return or the flow-based risk shift (equity fund flow minus bond fund flow), h is the event window running from $h = -5$ to h=20, $MP\ Shock_{j,t}$ is one of our three orthogonal monetary policy shocks as described in Section II, and $D_{FOMC,t}$ is a dummy variable that takes the value of one for the 80 scheduled FOMC meeting days between 2006 to 2015. As before, we standardize the monetary policy shocks such that the slope coefficients b_h show the impact of a unit standard deviation shock (as in Figures 1 to 3).

>>> FIGURE 4 ABOUT HERE <<<

We start with our measure of risk appetite shocks and find that stock returns are are highly sensitive to risk appetite shocks on FOMC days. Figure 4 summarizes the results. Reproducing our finding from above, a one unit standard deviation increase in risk appetite on FOMC announcement days goes hand in hand with a highly significant rise in equity returns by 0.82% (NW t-statistic of 7.4) on FOMC days. However, as is also evident from Figure 4, the impact of risk appetite shocks on stock prices is rather transitory. After about one week, the initial increase in equity prices relative to bond prices begins to melt way and is almost fully reversed after four weeks.

Turning to the reaction of quantities (lower panel of Figure 4), we find that investors' portfolio reallocation decisions quite closely follow the price response discussed above (upper panel of Figure 4). More precisely, a one unit standard deviation increase in risk appetite leads to significant shifts from bonds to equities of 0.38% (NW t-statistic of 2.6) on FOMC announcement days. In the following couple of days, the shift from bonds to equities continues and cumulates to about 1.1% after one week. After about two weeks, these reallocations are starting to reverse with investors pulling out from equities and back into bonds, mirroring the pattern for prices.

The effect of risk appetite shocks is economically large. The annualized effect of a one-standard deviation shock raises equity returns by 6.6% p.a. (=0.82%×8). This is as large as historical estimates of the unconditional equity premium. The behavior of quantities is remarkably similar. The flow-based risk shift reaches about 1.1% after one week. A one-standard deviation risk appetite shock thus corresponds to an annualized 8.8% reallocation from bonds to stocks.

While these findings suggest a strong role for risk appetite shocks to affect bonds and stocks, we do not find a prominent role for the two yield-based monetary policy shocks as drivers of equity returns around FOMC events at any horizon (see Figure IA.5 in the Internet Appendix). Neither short-rate nor long rate shocks have a significant effect on equity prices and/or flows around FOMC days.

Table 4 presents numerical results for the risk appetite shocks as well as results for the short rate and long rate shocks. For the sake of completeness, the table also provides results separately for the corresponding equity and bond legs of the equity premium and risk shifts.

>>> TABLE 4 ABOUT HERE <<<

We find that both yield-based factors have a significant and persistent impact on bond returns, as might be expected. However, they do not have any significant relationship to equity returns. We also do not find that short rate and long rate monetary policy shocks trigger any sizeable and significant risk shifts.

D. *Evidence from other asset classes*

Our fund dataset allows us to study the impact of risk appetite shocks on a broader set of asset classes, as shown in Table 5. For the additional bond categories, the sample is shorter and starts in 2010. We find that a risk appetite shock on FOMC days leads to significantly higher returns in corporate bonds (+0.11%, t: 3.6), high yield bonds (+0.32%, t: 4.1), and emerging market bonds (+0.28%, t: 3.4) compared to U.S. government and investment grade bonds ("broad" market bonds). Similarly, emerging market equities outperform U.S. equities by 0.40% (t: 4.4).

Investor flows are largely the mirror image of the return patterns. They indicate significant outflows from the safe asset and inflows into its more risky counterpart at the weekly horizon. Interestingly, we find that the effects on investment grade and high yield bonds are largely reversed after about 20 days. Overall, the results from other risk premia are broadly similar to the previous section that focuses on the U.S. equity premium.

>>> TABLE 5 ABOUT HERE <<<

Pricing of equities and bonds: Motivated by this finding, we run formal asset pricing tests for a cross-section of bond and equity returns as test assets. The results are reported in the Internet Appendix. The analysis is similar to Savor and Wilson (2014), who show that the CAPM can explain the cross-section of stock returns and other asset classes on FOMC announcement days. We extend their findings by showing that our risk appetite shocks can equally well explain asset returns across different asset classes on FOMC announcement days.

E. Further evidence from equity factor returns

In the Internet Appendix to the paper, we provide results for regressions of the Fama and French (2015)-factors on our three monetary policy shocks 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*. 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, which is in line with the evidence from prices.

V. What explains our results?

In this section, we shed light on *why* we observe such strong price movements around FOMC announcements as we have documented in the previous section. At the outset, there are two main possibilities, as also emphasized by Bernanke and Kuttner (2005). First, monetary policy may lead investors to change their expectations of future returns, or future cash-flows. Second, the large movement in stock prices could be, at least in part, due to price pressure driven by high demand for risky assets by some investors. In the following, we discuss the relative contributions of these two channels as potential drivers of the patterns we see in the data.

A. Discount rate news

Given the highly transitory nature of the price reaction on FOMC days (see Figure 4), it seems unlikely that cash-flow news are the drivers of risk appetite shocks. 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 be highly related to risk appetite shocks. These measures of expected returns are highly persistent and their effect on equity prices have half-lives of several quarters or even years.

Instead, recently proposed short-horizon equity premium predictors are prime candidates to test the idea that discount rate news might underlie risk appetite shocks. 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, 2017).

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 three VAR model specifications to also provide evidence on the model specifications' stability. In the first specification, the only return predictor is the lower bound on the equity premium (Martin, 2017).[11] In the second specification, we include the variance risk premium (Bollerslev, Tauchen, and Zhou, 2009) as an *additional*

[11]We have only data on the lower bound on the equity premium up to 08/2014, and therefore the analysis in this section is for a slightly shorter sample period (69 FOMC days).

predictor. The third VAR also adds the dividend-price ratio to the model specification.[12]

Finally, we also consider an (almost) model free specification by just looking at the change in Martin (2017)'s lower bound of the equity premium at the one year horizon.[13] The residual, or unexplained return component, is traditionally interpreted as cash-flow news. This interpretation stems from the accounting identity underlying the Campbell-Shiller decomposition and is natural when looking at low frequency data (quarterly, annual). However, as we are looking at daily data, the residual could also reflect liquidity effects (price pressure).

>>> FIGURE 5 ABOUT HERE <<<

Figure 5 illustrates the response of asset prices to scheduled monetary policy events. The black line shows the reaction of the total return (as before), and the colored lines represent the return component that can be attributed to changes in expected returns ($-1\times$ discount rate news). Thus, the difference between the black line and the colored line can be interpreted as the residual return component.

We find that short-term fluctuations in risk premia play a prominent role on FOMC days but we also find that stock returns move more than what can be justified by discount rate news alone. For example, we find that up to 50% of the initial return reaction can be explained by shifts in expected returns. The other 50% (the difference between the black line and the colored lines) are highly transitory and shrink towards zero after just one week. This finding speaks against the idea that the residual captures cash-flow news, as these can be expected to be persistent. However, this finding is well in line with the notion that price pressure effects amplify discount rate shocks on FOMC days.

[12]The VAR-based return decompositions employed here are standard so we refer to the Internet Appendix (see Table IA.5) for details on the computations to save space.

[13]This is clearly a very conservative estimate because it is a) a lower bound and b) it ignores changes in expectations from the one-year horizon onwards. However, this proxy cannot suffer from overfitting or sample selection issues, as the relationship with expected returns does not need to be estimated.

B. Some evidence on the potential sources of risk appetite shocks

In this subsection, we dig deeper into the potential sources of discount rate changes associated with risk appetite shocks. We have documented that risk appetite shocks are highly correlated with innovations in the variance risk premium (in the following abbreviated as *VRP*, Bollerslev, Tauchen, and Zhou, 2009) and innovations in the lower bound on the equity premiumimplied by option prices (in the following abbreviated as *EP*, Martin, 2017). In our context, a natural candidate mechanism for affecting discount rates is an 'uncertainty channel' such that monetary policy announcements increases or decreases market participants' uncertainty. These changes in uncertainty would in turn be responsible for moving the *VRP* as well as the *EP* and show up in our measure of risk appetite.

As is well known, leading equilibrium asset pricing models (e.g., Campbell and Cochrane, 1999, Bansal and Yaron, 2004) do not generate (substantial) variation in the *VRP* and option implied volatilities. This motivates Bollerslev, Tauchen, and Zhou (2009) to develop a model that combines Epstein-Zin preferences with an economy that is subject to time-varying uncertainty of uncertainty. Their model can give rise to short horizon variation in expected returns that is mirrored in changes in the variance risk premium as well as changes in option implied volatility. This is qualitatively in line with our empirical results around FOMC meetings documented above.[14]

Textual analysis of market commentary. To examine whether changes in uncertainty might move discount rates around FOMC meetings, 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*. *Thomson Reuters Instant View* collects

[14]However, Martin (2017) shows, in a comprehensive comparison of alternative equilibrium asset pricing models, that none of the considered models can quantitatively match the properties of the *EP* (models under study include Campbell and Cochrane, 1999, Bansal and Yaron, 2004, Bollerslev, Tauchen, and Zhou, 2009, Bansal, Kiku, and Yaron, 2012, Drechsler and Yaron, 2011, Wachter, 2013). In particular, the *EP* is more volatile and less persistent in the data relative to existing models. However, a high volatility and low persistence of discount rates a key to matching our findings as well. In short, existing equilibrium asset pricing models are unlikely to be able to explain the variation in key asset price moments on monetary policy announcement days. They all seem to understate, to a greater or lesser extent, the role of uncertainty shocks at the short horizon.

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 80 FOMC announcements and do not select particular analysts or firms. We then run a simple textual analysis on these market commentaries and count the number of occurrences of specific words related to economic and financial conditions as well as words related to surprises and uncertainty. We then regress the size of our three monetary policy shocks (the absolute value of the shock) on the frequency of these words for the 80 FOMC meetings in our sample. Table 6 reports the results of these regressions.

>>> TABLE 6 ABOUT HERE <<<

First, we count the frequency of words related to economic or financial conditions: inflation, CPI, employment, monetary policy, easing, tightening, investor confidence, risk appetite, and uncertainty. Panel A of Table 6 shows that economic conditions (inflation, employment) do not explain a large share of the size of the shocks. Easing and tightening are most closely related to short rate shocks and risk appetite shocks. A striking pattern is that the phrase "risk appetite" is indeed most closely related to our measure of risk appetite shocks. Moreover, in line with our discussion of a potential channel related to (resolution of) uncertainty above, the frequency of the term "uncertainty" itself is significantly related to the magnitude of risk appetite shocks.

Second, Panel B of Table 6, reports regression results for words related to surprises or the quality of information, i.e. words that start with shock*, surpris*, unexpected*, unpredict*, confus*, and vague*. We use these word stems to get a better sense of how important a channel based on (resolution of) uncertainty potentially is. First of all, and reassuringly, the frequency of words starting with surpris* (i.e., surprise, surprising, surprised etc.) is significantly related to all three monetary policy shocks, which suggests that our shocks are indeed related to new information hitting the market. Interestingly, we also find that the size of risk appetite shocks is significantly related to the frequency of words related to unexpected* and unpredict* which supports the view that our measure of risk appetite shocks relates to changes in uncertainty.

Moreover, we also find that the "quality" of new information (confus*, vague*) significantly relates to risk appetite shocks. Again, this suggests that changes in uncertainty induced by monetary policy play an important role as a driver of the patterns we see in the data.

C. *Price pressure*

We have shown above that there are quantitatively large flows from safe to risky assets around FOMC announcement days. In the following, we study the price pressures that may be associated with such reallocation shifts.

Big vs small ETFs. We label ETF flows as "fast money" because ETFs allow investors to obtain quick exposure to a particular asset class and because there is evidence that institutional investors make use of ETFs for (short-term) tactical asset allocation decisions (e.g., Ben-David, Franzoni, and Moussawi, 2013; Balchunas, 2016; Lettau and Madhavan, 2016, among others). Accordingly, we would expect that especially large investors prefer big and more liquid ETFs over small and less liquid ETFs.

To test the idea that "fast institutional money" is a driving force behind the FOMC risk shift, we sort all ETFs that invest in U.S. 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 (9.03% p.a. vs 9.10% p.a.). They only differ in their total net assets, i.e., the availability of fund shares on the market and their liquidity.

>>> FIGURE 6 ABOUT HERE <<<

We document the effect of risk appetite shocks on FOMC days on "Big" minus "Small" in Figure 6 and find that risk shift reallocations are predominantly driven by big funds whereas small funds do not show important inflows (lower panel of Figure 6). In line with a price pressure story, big funds underperform small funds the days following a risk appetite shock by about 5 basis points (upper panel of Figure 6). The return wedge between big and small funds disappears in the following days, mirroring the flow pattern. We interpret the underperformance of big funds as a liquidity fee for providing timely exposure to the stock market.

The returns to liquidity provision. To shed further light on the price pressure hypothesis, we investigate returns to a short-term reversal (STR) strategy around FOMC events. An STR strategy buys the last day's loser stocks and finances this position by selling the last day's winner stocks. Nagel (2012) shows that STR returns proxy for the returns to liquidity provision in equity markets.

>>> FIGURE 7 ABOUT HERE <<<

Figure 7 shows results from event-time projections of short-term reversal returns on the *absolute* values of risk appetite shocks on FOMC announcement days. We use absolute values of risk appetite shocks here since it seems natural that both good and bad shocks would lead to reallocations and drive up the returns to liquidity provision. In line with the price pressure hypothesis, we find that risk appetite shocks lead to a greater return to liquidity provision on FOMC days. In accordance with the risk shift pattern in flows documented above, the short-term reversal return further increases up to a sizeable 50 basis points after one week.

Overall, these results suggest that institutional investors are particularly sensitive to changes in risk appetite triggered by monetary policy news. They react with large reallocations between bonds and equities as well as other risky assets. These flows in turn lead to significant price pressure effects and high returns to liquidity provision around FOMC meetings.

VI. Further Results & Robustness

This section provides further results and robustness checks: We extend the sample period back to 1996, we look at mutual funds versus ETFs, and we study the high-frequency timing of risk appetite shocks to make sure that these shocks are not simply a manifestation of the pre-FOMC drift documented in Lucca and Moench (2015).

Extended sample (1996-2015): We extend the sample to 1996 by focusing on returns and flows to 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 U.S. 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. There are also no data on implied volatility of treasury bonds (TYVIX) and CDS spreads available for this time period. For that reason, we recalculate our monetary policy factors for the sub-sample from 1996 to 2005 using the VIX as the only risky asset. The results of the factor analysis are very similar to our baseline results and can be found in the Internet Appendix.

>>> FIGURE 8 ABOUT HERE <<<

Figure 8 provides the results for the full sample from 1996-2015 as well as the sub sample 1996-2005. The short-term reaction of returns and flows is very similar to the previous results. We find somewhat less return mean-reversion in week 4 in the earlier sample period. Whereas point estimates in the 2006-2015 indicate a complete reversal of the initial price reaction, the longer sample period indicates that about 1/3 of the initial price reaction is more persistent. This finding is not surprising, given the relative large confidence bands at longer horizons.

Mutual funds vs ETFs: It is interesting to contrast our results on risk shifts based on ETFs with those obtained when looking at mutual fund flows. We label mutual fund flows as "slow money". Mutual funds are typically subject to front-end fees and hence are not suited to gain short-term exposure to an asset class. Furthermore, a large investor base of mutual funds is retail clients, who are typically less responsive to news.[15] Based on this reasoning, we expect that mutual fund flows are not subject to (large) FOMC risk shifts.

As for the ETFs in the baseline results, we form equity minus bond fund portfolios and then compute the equity premium (prices) and risk shifts (flows). The Internet Appendix provides the results. We find that mutual fund flows do not respond in a meaningful way to risk appetite shocks triggered by monetary policy events. In fact, risk shifts remain flat within the event window. However, mutual fund returns follow the overall market, as one might expect.

Intraday returns and the pre-FOMC drift: Lucca and Moench (2015) show that from 1994-2011 a large part of average equity returns on FOMC days is earned ahead of FOMC announcements, a result they coin the "the pre-FOMC drift". A natural question in our context is whether the link between risk appetite shocks and returns materializes before or after the announcement. Our findings suggest that risk appetite shocks relate to changes in uncertainty so we would expected to find that most of the price action occurs after the announcement.

As a simple exercise, we first plot the high-frequency evolution of S&P500 intraday returns on all days that include a scheduled FOMC announcement on the left-hand side of Figure 9. In addition, we split the sample i) in FOMC days when we measure increasing "risk appetite" (green line) and ii) in FOMC days when we measure decreasing "risk appetite" (red line). For comparison, the right-hand side provides results conditional on long and short rate shocks.

>>> FIGURE 9 ABOUT HERE <<<

Figure 9 shows that there is a pre-announcement drift as in Lucca and Moench (2015). However, conditional on risk appetite shocks being positive or negative, almost all of the *variation* in

[15] See, for example, Frazzini and Lamont (2008).

stock returns occurs after the announcement. More specifically, at the time of the announcement (around 2pm) the difference in cumulative log returns between days with positive and negative risk appetite shocks is around 0.2% and statistically insignificant. After the announcement, this return spread grows to around 1% and is significantly different from zero. For comparison, short and long rate shocks do not generate variation in stock returns that survives until the end of the trading day.

To formalize this finding, we decompose S&P500 returns into a pre- and post-announcement component and look at these return components for days with positive and negative risk appetite shocks separately. Figure 10 shows average stock returns on FOMC days from 9:30 to 16:00, as well as the pre-announcement return from 9:30-12:15 and the post announcement return from 12:15-16:00.[16] Indeed, we find that about one-half of the average intraday return is earned ahead of FOMC meetings; the Lucca and Moench (2015) result is largely robust to our sample period. The figure also provides results *conditional* on observing a positive or a negative risk appetite shock. We find that the stock return *conditional* on a risk appetite shock is earned *after* the announcement. In contrast to Lucca and Moench (2015), there is no *conditional* pre-FOMC drift.

>>> FIGURE 10 ABOUT HERE <<<

Figure 10 also provides a variance decomposition of intraday returns on all FOMC days, and on FOMC days *conditional* that we observe a positive or negative risk appetite shock. We find that almost all of the variation of returns can be attributed to the time after FOMC announcements.

[16] Lucca and Moench (2015) use 14:00 as the cut off time to measure pre announcement returns. However, in our sample, there are 8 FOMC announcements that take place between 12:15 and 14:00; all other 72 announcements take place after after 14:00. For that reason we use 12:15 to separate pre and post announcement returns.

VII. Conclusion

The goal of this paper is to better understand the strong stock market reaction to news about monetary policy. To shed light on the underlying drivers we rely on factor-analysis and fund flows to sharpen the analysis of monetary policy shocks around FOMC meetings. A key finding is that the lion's share of the stock market's reaction to monetary policy shocks is driven by changes in risk appetite. Changes in short-term and long-term yields induced by monetary policy play a very minor role in explaining the response of the stock market.

The behavior of quantities matches that of prices in a remarkably consistent way. A pick-up in risk appetite is associated with a significant shift from fixed income to equity fund flows. Similar reallocations can be observed for emerging market bonds, emerging market equities, and corporate bonds. We provide evidence that these risk shifts by largely institutional investors trigger significant price pressure effects. Consistent with this finding, we observe that the compensation for liquidity provision rises significantly in these episodes.

Closer inspection of the mechanism reveals that shifts in our measure of risk appetite are closely related to measures of expected returns. For example, we show that positive realizations of risk appetite shocks are accompanied by a decline in discount rates implied by the classic Campbell and Shiller (1988) VAR approach as well as (almost) model free shifts in option-implied measures of the equity premium. Moreover, textual analysis of market commentary after FOMC meetings suggests that risk appetite shocks relate to changes in uncertainty.

Our results provide a new perspective on monetary policy's role in affecting the equity premium. Monetary policy moves the stock market not via its impact on the term-structure of risk-free interest rates, as conventional wisdom suggests. Instead, we detect a direct and distinct impact of monetary policy on investors' risk perception that seems to drive the lion's share of equity price and flow reactions around monetary policy meetings. Our analysis of flows provides evidence that investors react heterogeneously to changes of uncertainty induced by FOMC meetings. A deeper theoretical analysis of these channels constitutes an interesting avenue for future research.

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Table 1: Monetary Policy Shocks

We collect the following nine variables at the daily frequency for the sample period from 2006 to 2015: simple changes of the three and six month rates of the Overnight Indexed Swap (OIS, available via Datastream), simple changes of the Guerkaynak, Sack, and Wright (2007) two, five, and ten year zero-coupon treasury yields (TS, from the Fed website of Refet GÃŒrkaynak), log changes of an industries portfolio of CDS spreads (CDS, Datastream; the covered industries are banks, chemicals, health care, technology and telecommunication - the five industries are equally weighted), the log change of the Fed's trade weighted dollar index broad (DOL, available via FRED of St.Louis Fed; denomination is in FCUs for one USD), the log change of the squared CBOE Volatility Index (VIX^2, from FRED of the St.Louis Fed), and the log change of the squared CBOE/CBOT 10-year U.S. Treasury Note Volatility Index ($TYVIX^2$, from FRED of the St.Louis Fed). We normalize all nine variables by their full sample standard deviation. The standard deviation conditional on FOMC announcement days is reported below "$\sigma^2_{FOMC}/\sigma^2_{All}$". In a first step, we run a principal component analysis on scheduled FOMC announcement days (80 observations) to extract statistical factors (results below "PCA on FOMC Days"). Following Swanson (2017), in a second step, we apply a standard (orthogonal) factor rotation on the first three principal components to extract economic monetary policy shocks (results below "Orthogonal Factor Rotation"); * indicate our target matrix. The obtained shocks are labeled: "Short Rate", as these shocks load on short maturity yields; "Long Rate", as these shocks load on long maturity yields; and "Risk Appetite", as these shocks load negatively on risky assets (CDS, DOL, VIX^2, and $TYVIX^2$).

	Monetary Policy Shocks						
	PCA on FOMC Days (#80)			**Orthogonal Rotation**			
	(1)	**(2)**	**(3)**	**"Short Rate"**	**"Long Rate"**	**"Risk Appetite"**	$\frac{\sigma^2_{FOMC}}{\sigma^2_{All}}$
$\triangle OIS(3M)$	0.27	-0.65	-0.02	0.71*	-0.02	0.02	2.37
$\triangle OIS(6M)$	0.29	-0.59	-0.04	0.66*	0.02	-0.02	2.12
$\triangle TS(2Y)$	0.43	-0.05	0.10	0.21	0.39	0.02	1.87
$\triangle TS(5Y)$	0.50	0.23	0.09	-0.01	0.55*	-0.03	2.43
$\triangle TS(10Y)$	0.42	0.33	0.15	-0.14	0.54*	0.03	2.27
$\triangle log(CDS)$	-0.11	-0.06	-0.40	0.03	-0.21	-0.36	1.01
$\triangle log(DOL)$	0.46	0.22	-0.30	0.00	0.44	-0.40	3.32
$\triangle log\left(VIX^2\right)$	0.01	0.06	-0.62	-0.03	-0.11	-0.62*	1.32
$\triangle log\left(TYVIX^2\right)$	0.07	0.04	-0.56	0.01	-0.04	-0.57*	1.14
Var. expl.,%	71.03	15.66	9.05				

Table 2: Average FOMC Returns and Monetary Policy Shocks

This table reports average daily excess returns (equities minus bonds, in percentage points) and average monetary policy shocks (normalized to a unit standard deviation on all days) on 80 scheduled FOMC announcement days in the sample period from 2006 to 2015. HC robust GMM standard errors are reported in braces. *#pos* : *#neg* provides the number of positive and negative observations.

	Returns	**Monetary Policy Shocks**		
	Equity-Bond, %	**Short Rate**	**Long Rate**	**Risk Appetite**
mu	0.47	-0.11	0.15	0.59
s.e.	(0.17)	(0.17)	(0.19)	(0.13)
#pos : *#neg*	51:29	41:39	47:33	59:21

Table 3: Reaction Returns to Monetary Policy Shocks on FOMC days

This table reports daily excess returns (equities minus bonds, in percentage points) on 80 scheduled FOMC announcement days, conditional on the three different monetary policy shocks. The upper panel shows results from regressions of returns on monetary policy shocks on FOMC days. The lower panel shows average returns conditional on observing a positive or a negative monetary policy shock. The sample period from 2006 to 2015. HC robust GMM t-statistics / standard errors are reported in braces.

	Equity-Bond, Daily Returns %		
	Short Rate	**Long Rate**	**Risk Appetite**
	$R_{t\|FOMC} = a + b \times MP\ Shock_{t\|FOMC} + \xi_{t\|FOMC}$		
a	0.49	0.45	-0.01
$t(a)$	(3.08)	(2.66)	(-0.09)
b	0.20	0.12	0.82
$t(b)$	(1.07)	(0.83)	(7.35)
R^2	0.04	0.02	0.45
	Conditional Average Returns		
$mu_{MP\ Shock \geq 0}$	0.40	0.68	0.86
$s.e.(mu_{MP\ Shock \geq 0})$	(0.25)	(0.20)	(0.17)
$mu_{MP\ Shock < 0}$	0.54	0.17	-0.62
$s.e.(mu_{MP\ Shock < 0})$	(0.22)	(0.27)	(0.29)

Table 4: Permanent and Transitory Effects of Monetary Policy Shocks

This table reports the effect of a unit standard deviation monetary policy shock on fund returns and 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:

$$X_{t+h} = a + b_h \times Monetary\ Policy\ Shock_{j,t} \times D_{FOMC,t} + \xi_{t+h},$$

where X_{t+h} is the fund return, or flow, at time $t + h$, $Monetary\ Policy\ Shock_{j,t}$ is one of the three orthogonal monetary policy shocks: i) short rate, ii) long rate, and iii) risk appetite (see Table 1 for details), and $D_{FOMC,t}$ is a dummy variable which is one on FOMC announcement days. T-statistics are HAC robust (Newey-West, 20 lags); inference on cumulated effects is based on the full b coefficient covariance matrix. The sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.

	Returns, %			**Flows, %**		
	"Equity Premium" Equity-Bond	**Equity**	**Bond**	**"Risk Shift" Equity-Bond**	**Equity**	**Bond**
	Short Rate Shocks on FOMC Days					
b_0	0.17	0.14	-0.04	-0.07	-0.11	-0.03
$\sum_{h=0}^{5} b_h$	0.19	0.12	-0.07	-0.22	-0.10	0.11
$\sum_{h=0}^{20} b_h$	0.26	0.10	-0.16	0.44	0.04	-0.40
t_0	0.81	0.67	-2.05	-0.46	-0.84	-0.45
$t_{\sum 5}$	0.76	0.52	-1.38	-0.75	-0.68	0.36
$t_{\sum 20}$	0.58	0.24	-1.53	1.33	0.13	-1.74
	Long Rate Shocks on FOMC Days					
b_0	0.13	-0.03	-0.16	-0.21	-0.19	0.03
$\sum_{h=0}^{5} b_h$	0.15	-0.03	-0.18	0.36	0.17	-0.19
$\sum_{h=0}^{20} b_h$	-0.33	-0.50	-0.17	0.37	0.29	-0.08
t_0	0.82	-0.18	-22.46	-1.99	-1.98	0.52
$t_{\sum 5}$	0.50	-0.10	-2.96	1.29	0.87	-0.97
$t_{\sum 20}$	-0.73	-1.19	-3.52	0.83	0.95	-0.26
	Risk Appetite Shocks on FOMC Days					
b_0	0.82	0.84	0.03	0.38	0.34	-0.04
$\sum_{h=0}^{5} b_h$	0.69	0.78	0.09	1.11	0.48	-0.63
$\sum_{h=0}^{20} b_h$	0.14	0.33	0.19	0.23	-0.25	-0.48
t_0	7.43	8.08	1.03	2.62	3.30	-0.44
$t_{\sum 5}$	3.13	3.87	1.56	2.81	1.71	-2.27
$t_{\sum 20}$	0.38	1.07	2.08	0.41	-0.92	-1.04

Table 5: Other Risky Asset Classes and Risk Appetite Shocks

This table reports for an extended set of risky asset classes the effect of a unit standard deviation risk appetite shock on fund returns and fund flows on FOMC announcement days ($h = 0$), the cumulated impact over the next 5 days ($h = 5$), and the next 20 days ($h = 20$). Estimation and inference is as described in Table 4. The risky asset classes are proxied by long-short strategies based on Morningstar categories: "Corp.-Broad" is corporate minus all broad and U.S. government bond funds, "HY-Broad" is high yield minus all broad and U.S. government funds, "EM-US Bonds" is emerging market bond minus all broad and U.S. government bond funds, and "EM-US Equities" is emerging market equity minus minus all U.S. blend equity funds. The max. sample period is from 2006 to 2015 (EM-US Equities) and is shorter for the bond categories. #FOMC reports the number of FOMC announcement days available.

Other Risky Asset Classes & Risk Appetite Shocks				
	Bonds			**Equities**
	Corp.-Broad	**HY-Broad**	**EM-US**	**EM-US**
#FOMC	**48**	**48**	**44**	**80**
		Returns, %		
b_0	0.11	0.32	0.28	0.40
$\sum_{h=0}^{5} b_h$	0.17	0.26	0.47	0.29
$\sum_{h=0}^{20} b_h$	0.08	-0.25	0.24	0.92
t_0	3.63	4.10	3.36	4.43
$t_{\sum 5}$	3.42	1.41	2.75	1.57
$t_{\sum 20}$	0.86	-1.14	1.25	2.72
		Flows, %		
b_0	0.15	0.46	0.22	0.16
$\sum_{h=0}^{5} b_h$	0.92	1.59	1.49	0.70
$\sum_{h=0}^{20} b_h$	0.03	-0.87	1.60	0.93
t_0	0.84	2.45	1.10	1.37
$t_{\sum 5}$	1.81	2.97	2.24	1.72
$t_{\sum 20}$	0.02	-0.67	1.22	1.08

Table 6: Textual Analysis of Market Commentary

We collect market commentary on FOMC announcement days from *Thomson Reuters Instant View.* We then count the frequency, $F_{i|\mathrm{FOMC}}$, of words that relates to economic and financial conditions (Panel A) or uncertainty (Panel B), and run the following univariate regressions: $|Z_{t|FOMC}| = a + bF_{i,\,\mathrm{t|FOMC}} + e_{t|FOMC}$, where$|Z_{t|FOMC}|$ is the absolute value of one of our three monetary policy shocks (short rate, long rate, and risk shocks). The sample period is from 2006 to 2015; 80 FOMC announcement days.

	Panel A: Words Related to Economic and Financial Conditions					
	Short Rate		**Long Rate**		**Risk Appetite**	
	b	R^2	b	R^2	b	R^2
Inflation	0.07	0.80	0.11	3.45	0.03	0.37
t	[0.79]		[1.79]		[0.53]	
CPI (or Cons. prices)	0.16	1.61	0.08	0.73	0.06	0.70
t	[1.13]		[0.76]		[0.74]	
Employment	0.06	1.80	0.04	0.98	0.05	2.59
t	[1.20]		[0.88]		[1.44]	
Monetary policy	0.07	0.20	0.07	0.37	0.11	0.13
t	[0.39]		[0.54]		[1.05]	
Easing	0.09	3.96	-0.01	0.02	0.06	3.07
t	[1.85]		[-0.12]		[1.87]	
Tightening	0.07	2.46	-0.01	0.10	0.06	2.85
t	[1.40]		[-0.28]		[1.82]	
Investor confidence	0.10	4.34	0.09	5.88	0.08	6.32
t	[1.88]		[2.21]		[2.29]	
Risk appetite	0.13	3.72	0.17	11.38	0.24	35.24
t	[1.76]		[3.17]		[6.52]	
Uncertainty	0.12	6.02	0.05	1.84	0.11	11.58
t	[2.24]		[1.21]		[3.37]	

	Panel B: Words Related to Surprises					
	Short Rate		**Long Rate**		**Risk Appetite**	
	b	R^2	b	R^2	b	R^2
shock*	0.02	0.43	0.02	0.87	0.05	11.67
t	[0.58]		[0.83]		[3.21]	
surpris*	0.02	8.85	0.02	10.74	0.01	9.53
t	[2.75]		[3.06]		[2.87]	
unexpected*	0.08	3.67	0.02	0.39	0.09	13.01
t	[1.70]		[0.56]		[3.42]	
unpredict*	-0.03	0.02	-0.17	1.07	0.37	8.38
t	[-0.13]		[-0.92]		[2.67]	
confus*	-0.01	0.09	0.04	2.69	0.06	11.7
t	[-0.27]		[1.47]		[3.22]	
vague*	-0.05	0.23	0.01	0.03	0.15	5.54
t	[-0.43]		[0.15]		[2.14]	

Figure 1: Short Rate Shocks on FOMC Announcement Days

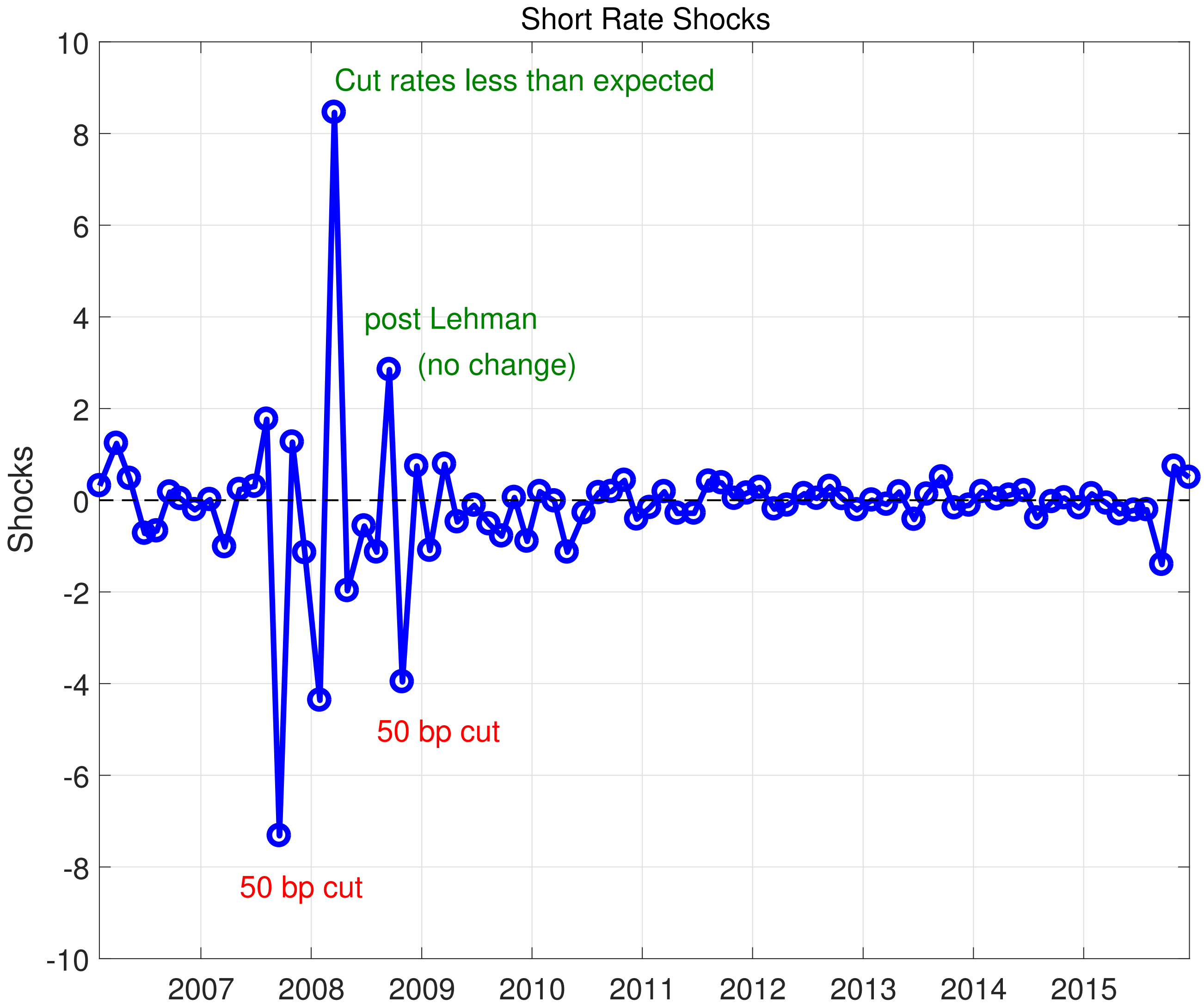


Figure 2: Long Rate Shocks on FOMC Announcement Days

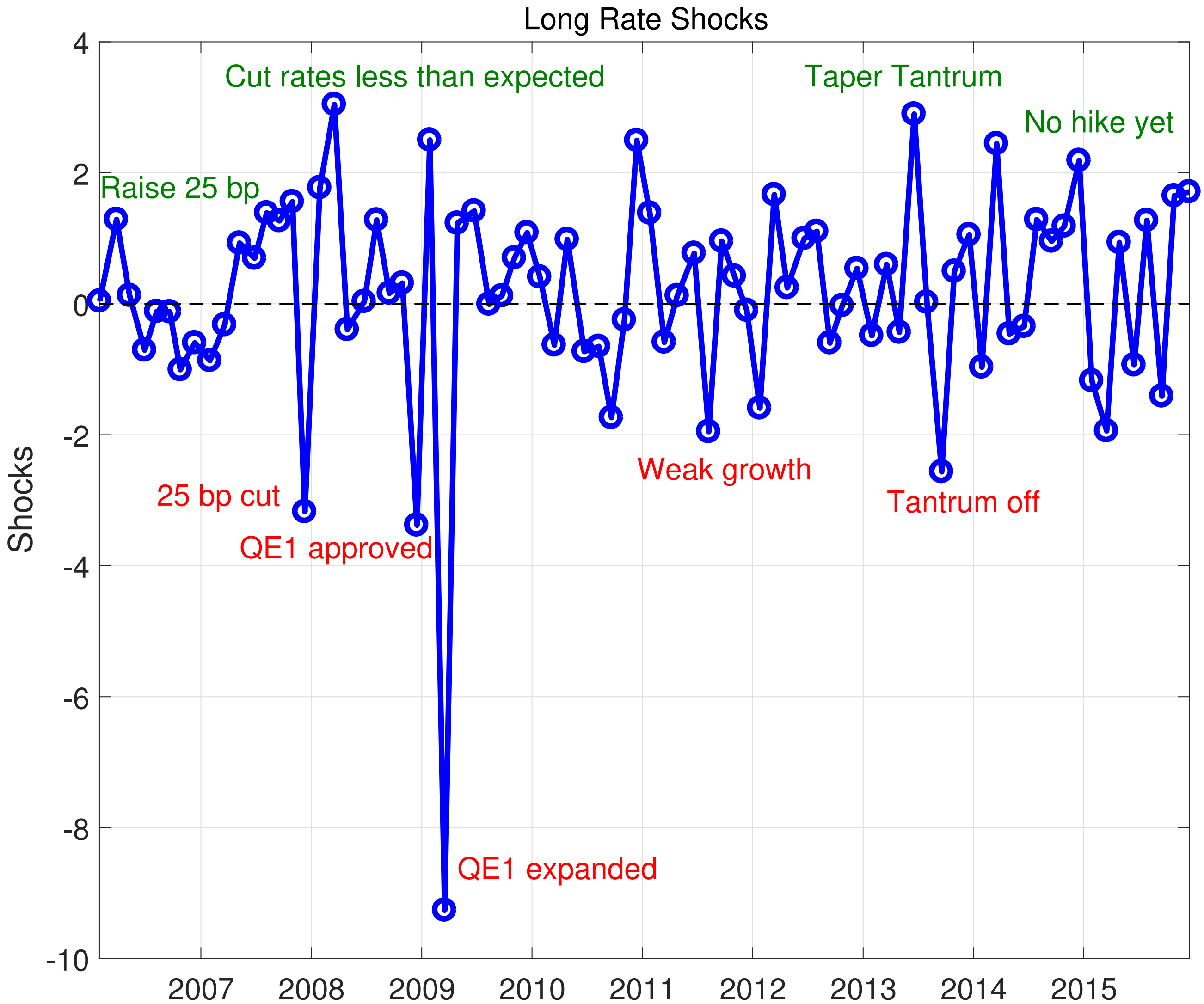


Figure 3: Risk Appetite Shocks on FOMC Announcement Days

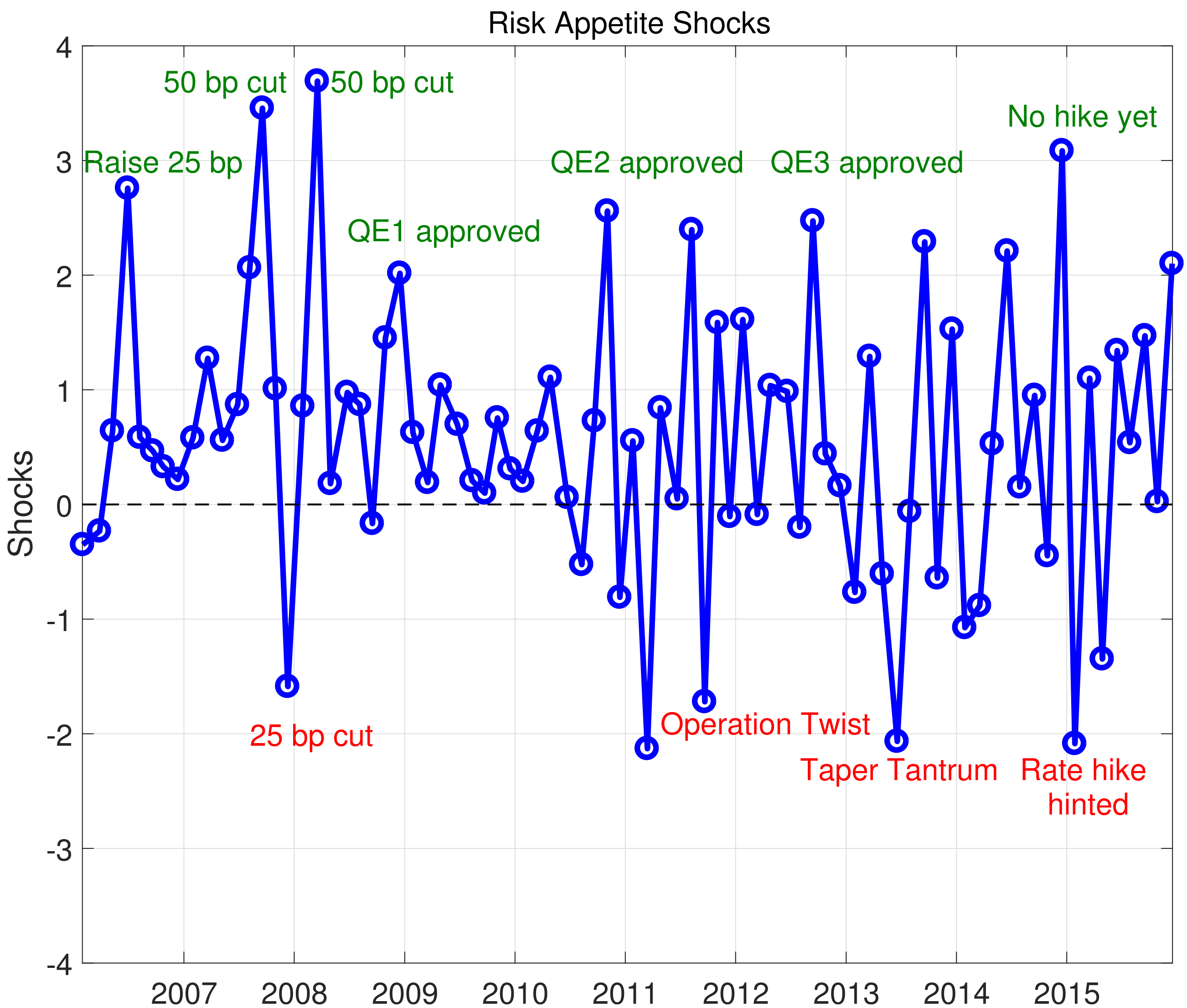
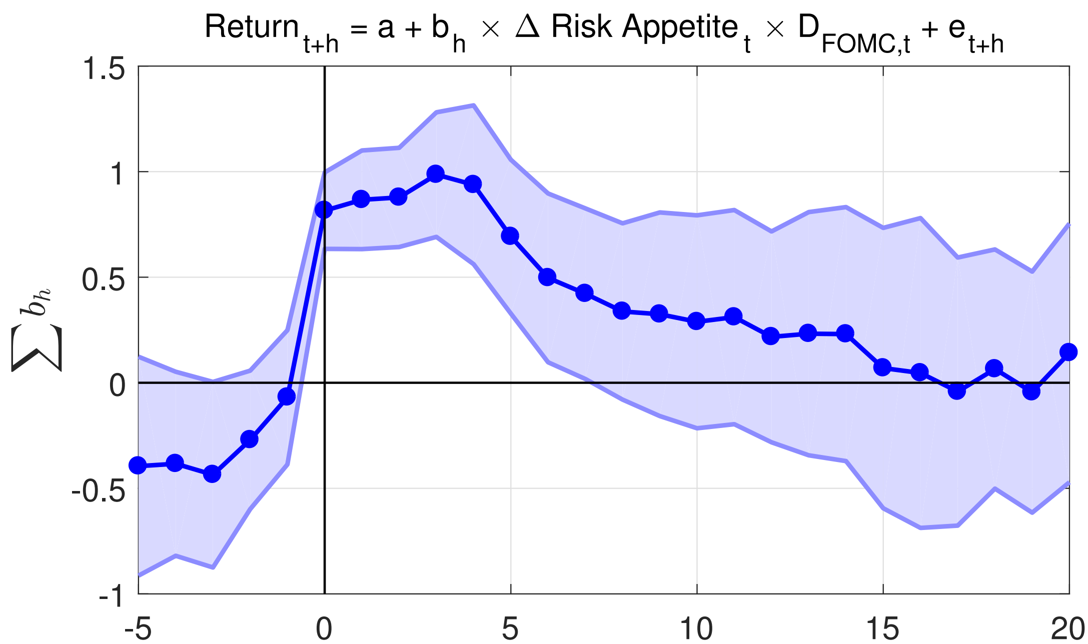


Figure 4: The FOMC Risk Shift

This figure shows the effect of a unit standard deviation risk appetite shock on the equity premium (equity ETF minus bond ETF returns, top) and risk shifts (equity ETF minus bond ETF flows, bottom) on FOMC announcement days (h=0) and the cumulative response in the event window -5 to +20 days. Estimation is based on the linear projections as described in Table 4. The shaded area represents HAC robust 90% confidence intervals. Returns and flows are measured daily (close-to-close); the sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.



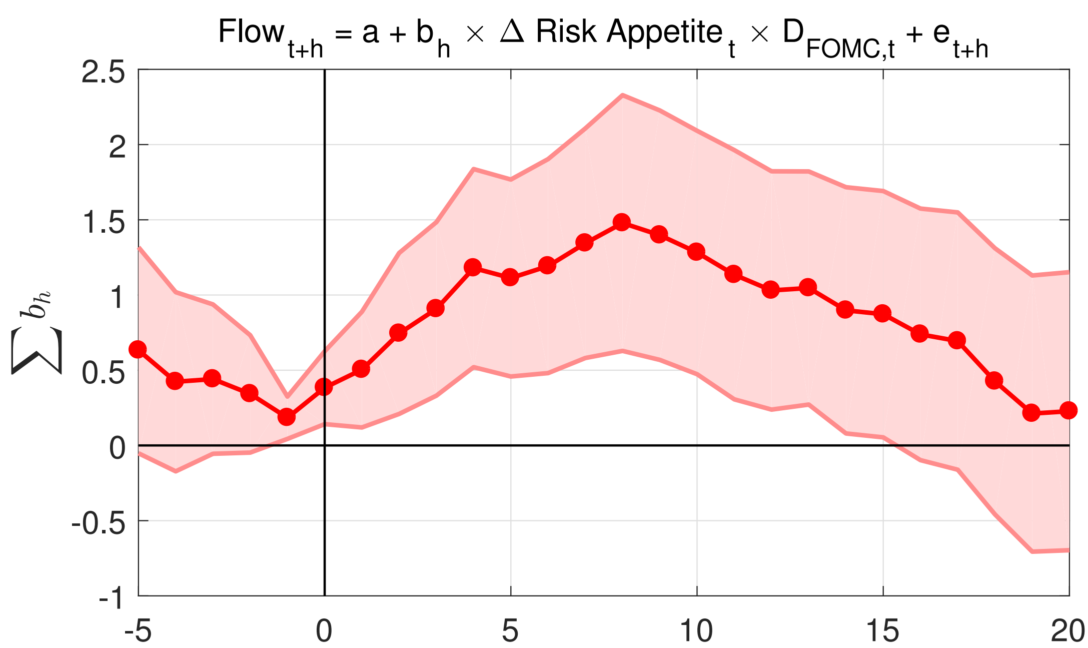


Figure 5: The FOMC Risk Shift: The Role of Discount Rate News

The black line plots the (cumulative) response of S&P 500 returns in excess of the (short-term) risk free rate to a unit standard deviation risk appetite shock on FOMC announcement days (h=0) in the event window -5 to +20 days. Colored lines correspond to the return component that can be attributed to "discount rate news". We use three standard VAR models to decompose daily returns into "discount rate news" and the residual (=distance from colored lines to the black line). In the first VAR (red), the only return predictor is the option implied lower bound on the equity premium ("EPLB") for the one month horizon (as in Martin, 2017), the second VAR (magenta) adds the variance risk premium ("VRP", as in Bollerslev, Tauchen, and Zhou, 2009) as a predictor, and the third VAR (blue) adds the dividend-price ratio ("DP") to the model. VAR parameter estimates are reported in the Appendix. The final proxy (green) is purely data driven and shows results for simple changes of the option implied lower bound on the equity premium for a horizon of one year (as in Martin, 2017). The sample period is from 2006 to 08/2014; 2180 observations with 69 scheduled FOMC announcements.

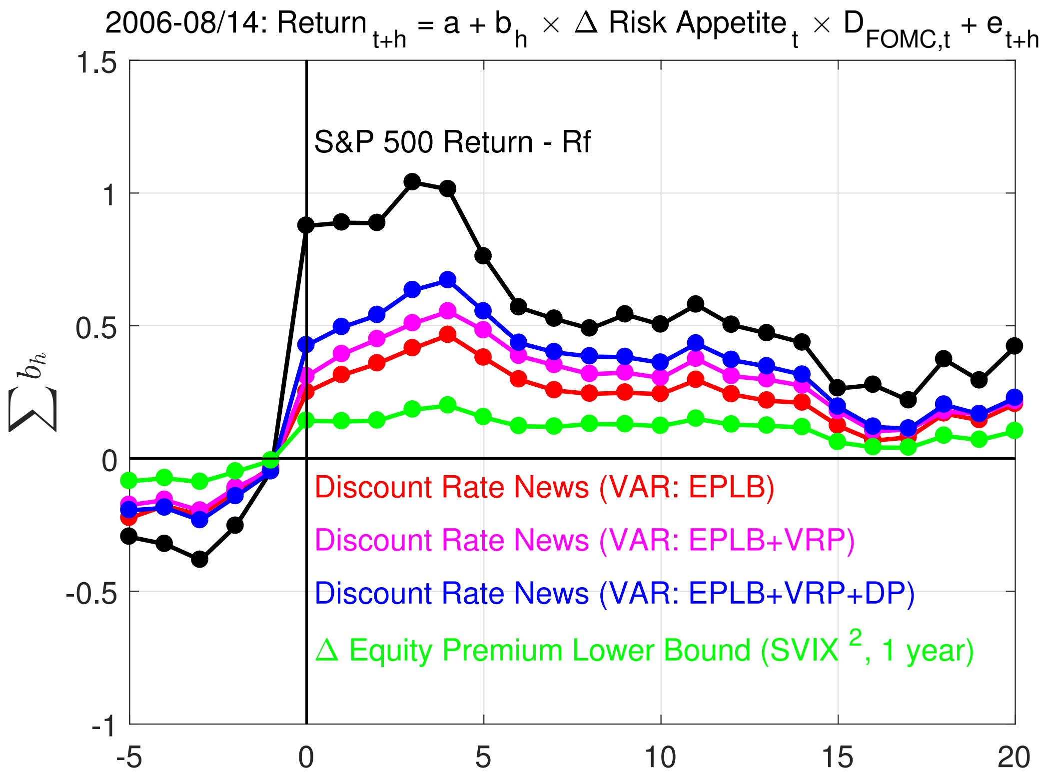


Figure 6: The Role of ETF Liquidity: Big minus Small Funds

In contrast to Figure 4, results are provided for returns and flows of BIG ETF funds minus SMALL ETF funds. ETF funds that invest in Blend U.S. stocks are sorted by their total assets under management and then grouped into large funds ("BIG", top 50%) or small funds ("SMALL", bottom 50%). Estimates are scaled such that they show the effect of a one standard deviation risk appetite shock on FOMC announcement days. The shaded area represents HAC robust 90% confidence intervals. BIG funds have an annualized average return 9.10%, SMALL funds have an annualized average return of 9.03%; the correlation coefficient for the returns is 0.98. Returns and flows are measured daily (close-to-close); the sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.

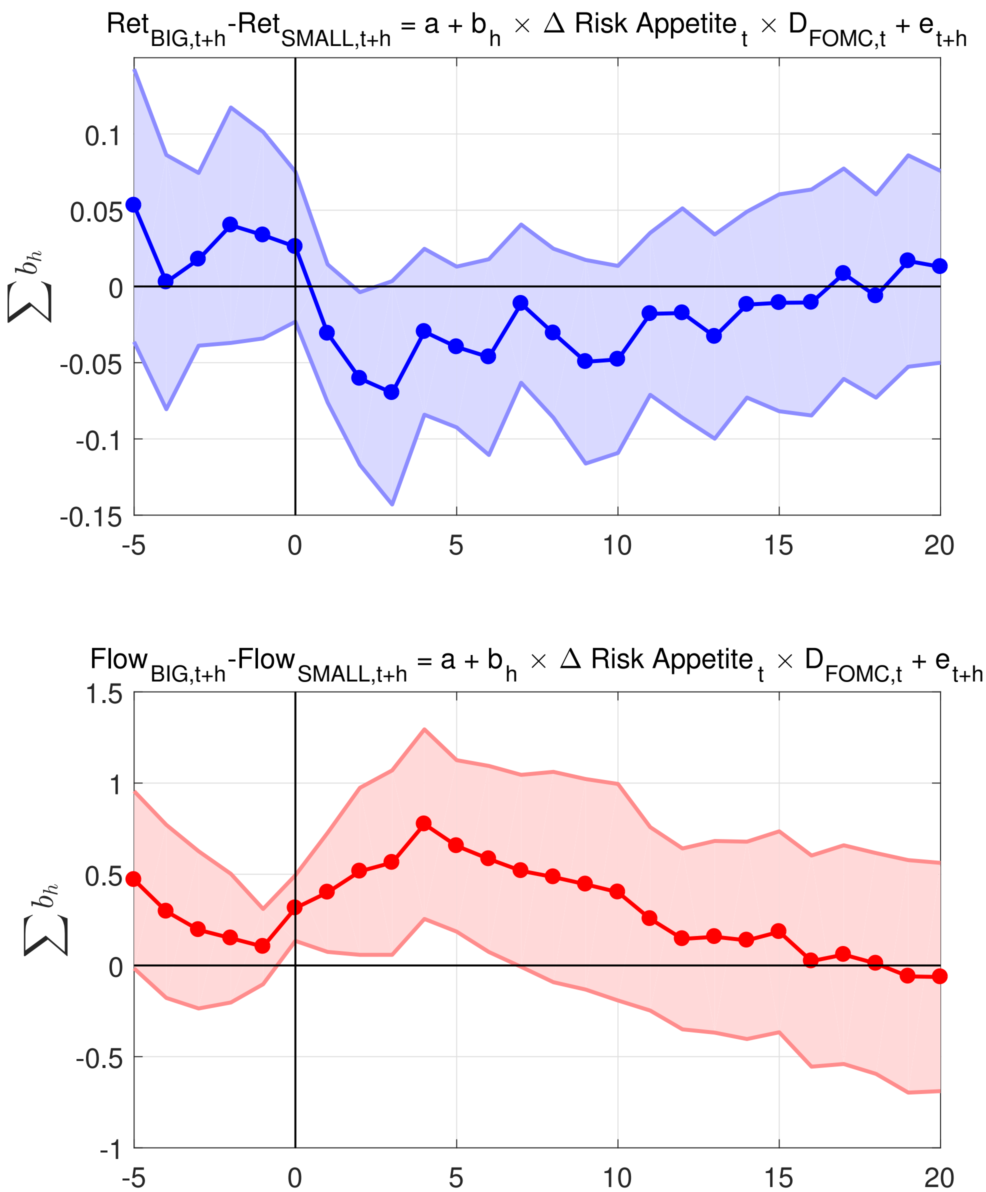


Figure 7: The Short-Term Reversal Strategy and Risk Appetite Shocks

This figure plots linear projections (Σb) of short-term reversal strategy returns (available from Kenneth R. French's website) on absolute risk appetite shocks on FOMC announcement days. Estimates are scaled such that they show the effect of a one standard deviation risk shock. CRSP stocks are sorted daily into 2×3 portfolios based on firm size and the prior day return. The short-term reversal strategy is the portfolio that goes long in the two loser portfolios and short in the two winner portfolios. The shaded area represents HAC robust 90% confidence intervals. The sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.

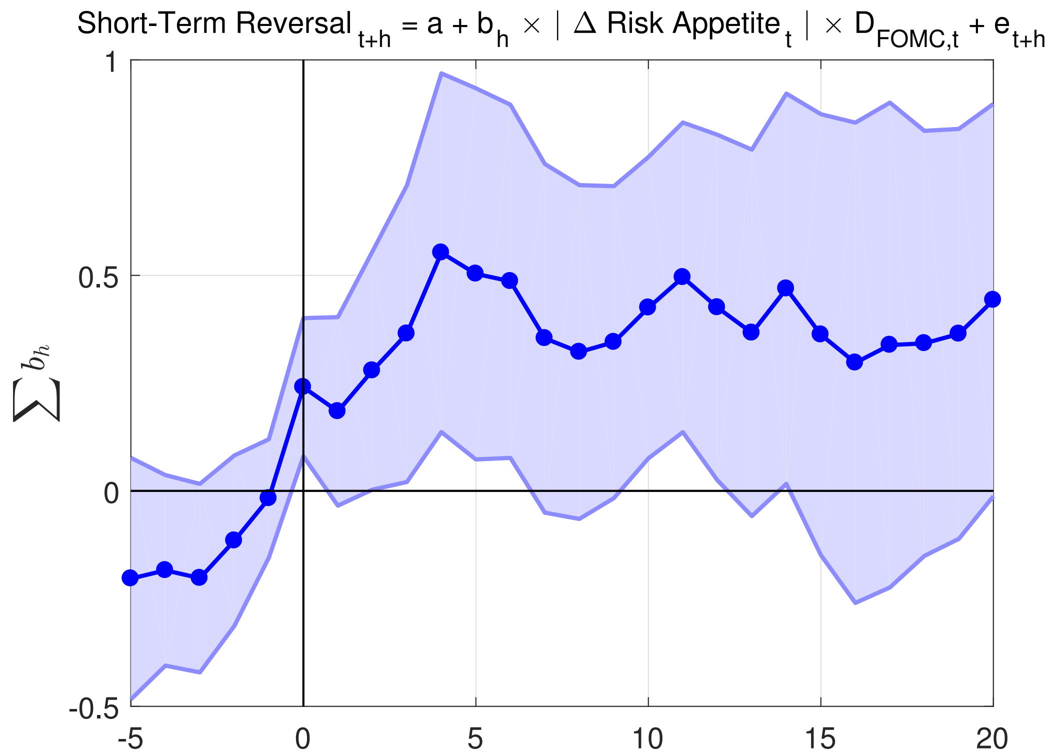
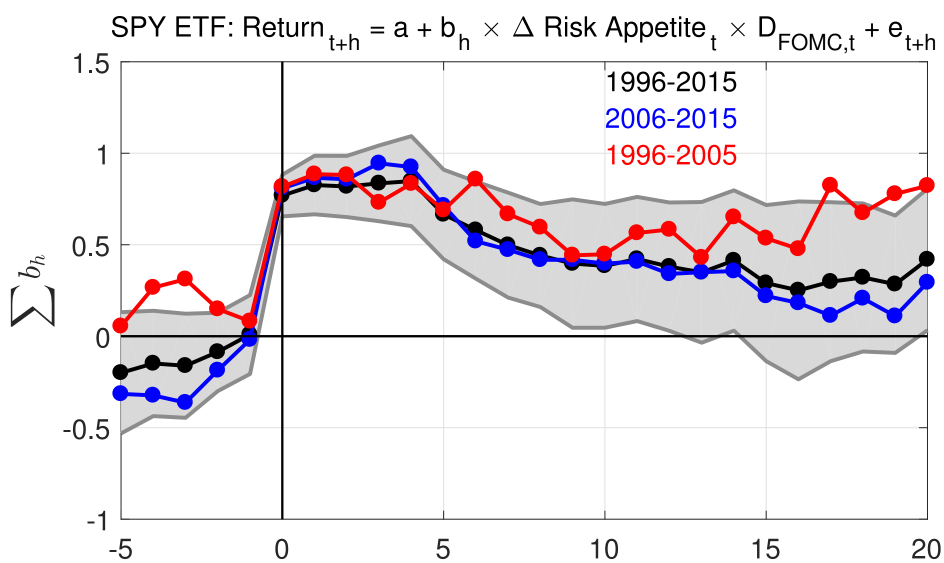


Figure 8: The SPDR S&P 500 ETF and Risk Appetite Shocks on FOMC Days from 1996-2015

In contrast to Figure 4, returns and flows are measured by the the SPDR S&P 500 ETF (ticker: SPY) from State Street Global Advisor's. No bond returns or flows are subtracted. Estimates are scaled such that they show the effect of a unit standard deviation risk appetite shock on FOMC announcement days. The SPY was the first ETF introduced in 1993 and is until today the largest U.S. equity ETF. Results are shown for an early sub sample (red, 1996-2005), the baseline sample (blue, 2006-2015), and the full sample (black, 1996-2015). In the early sample (2517 total obs.), we count 1464 zero flows for the SPY. Accordingly, no fund share creations, or redemptions, were triggered for more than one half of the observations in the early sample period. For the period 2006-2015 (2516 obs.), we count 61 zero flows, and almost always share creations, or redemptions, were triggered. Returns and flows are measured daily (close-to-close); the full sample period from 1996 to 2015 has a total of 5033 observations with 160 scheduled FOMC announcements.



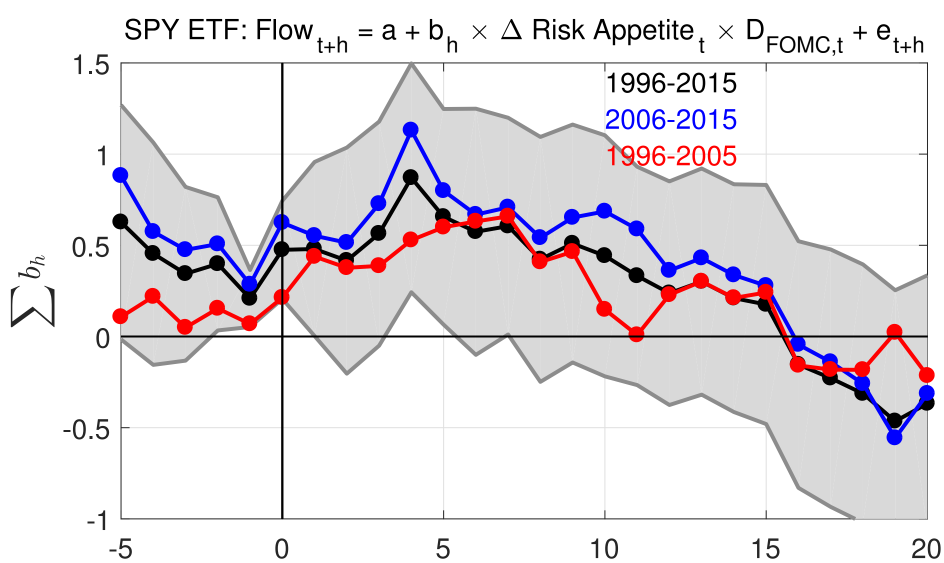


Figure 9: The S&P 500 Index on FOMC Announcement Days

This figure shows average cumulative S&P500 returns on FOMC days (based on one-minute data). Most FOMC announcements take place after 14:00, as indicated by the black dotted line; #8 out of #80 announcements are between 12:15 and 14:00.

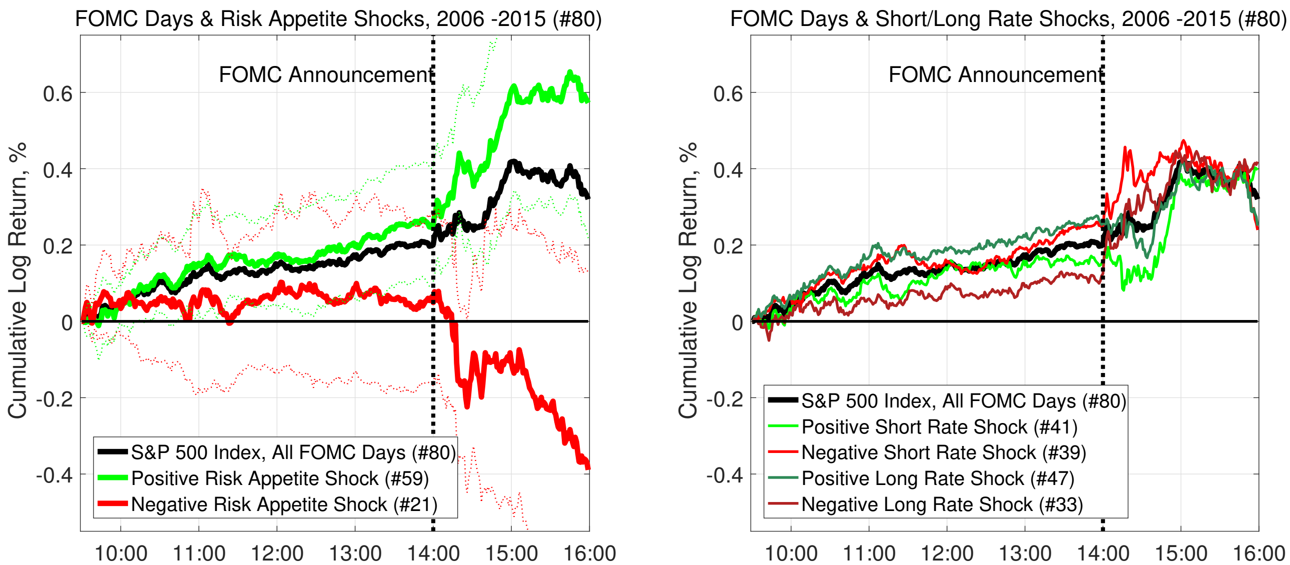
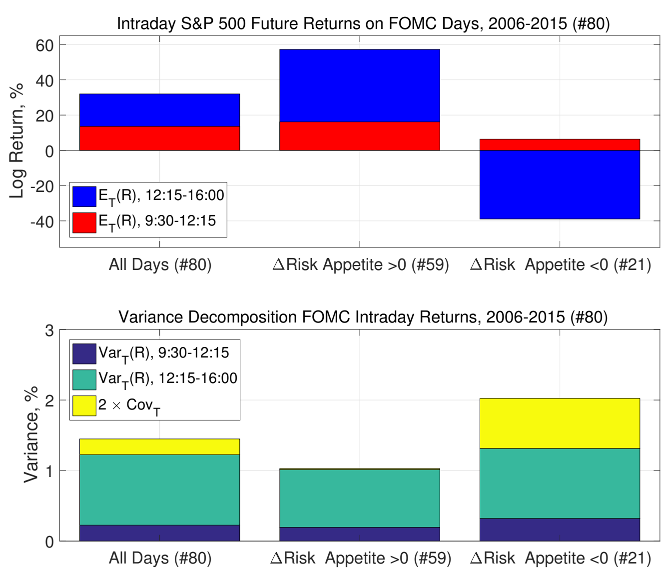


Figure 10: Intraday S&P 500 Future Returns on FOMC Days, 2006-2015

The upper figure shows average intraday S&P future log returns on all FOMC days (left), on FOMC days with a positive risk appetite shock (middle), and on FOMC days with a negative risk appetite shock (right). We split the sample (9:30 to 16:00) in pre-FOMC returns (9:30 to 12:15, red), and post-FOMC returns (12:15 to 16:00, blue). The lower figure provides a variance decomposition of 1-minute intraday returns using the same split of FOMC days and time around FOMC announcements.



Internet Appendix for

The FOMC Risk Shift

(not for publication)

Details on data and variables construction

We collect daily ETF (and mutual fund) data from Trimtabs.[17] The dataset covers (almost) all ETFs traded in the U.S., 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.[18]

We aggregate individual funds to asset classes. Our measure for U.S. equity is based on all funds that belonging to Morningstar's category "Blend".[19] Our measure for U.S. bonds is based on all funds that belong to the Morningstar categories U.S. "government", or investment grade "bond".[20]

Fund flows at the asset class level are measured as:

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

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.[21] Following Staer (2016), we move reported flows one day forward to account for the lag between fund share creation and reporting.[22] More importantly, to take delayed reporting into account, we allow flows to respond with lags in our empirical analysis.

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

[18] 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.

[19] Morningstar categorizes all U.S. 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.

[20] 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.

[21] 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.

[22] 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 (2016) and Lettau and Madhavan (2016), 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.

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 ensures that we almost always observe non-zero flows for "Blend" equity and "Broad" bond funds.

Descriptive statistics - returns and flows: Table IA.1 reports descriptive statistics for the equity premium and risk shifts, as well as their corresponding equity and bond legs. 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.

Further results on monetary policy shocks: Table IA.2 reports correlations and autocorrelations of all variables that we use to extract monetary policy news.

Table IA.3 shows results for a factor analysis extended to the sample period 1996-2015. For this extended sample period, the variables CDS spread, DOL and TYVIX are not available to us. For that reason, the VIX is the only market-based risk proxy in the long sample. Otherwise, the factor analysis for the extended sample period leads to very similar result as in the main paper.

Figure IA.2 plots the unconditional average factor realizations in FOMC announcement weeks. We find a flat pattern in the two yield-based factors and the unconditional response is not significantly different from zero. However, we find that risk appetite rises unconditionally on FOMC announcement days, mirroring unconditionally high returns on FOMC days.

Figure IA.1: Coverage of ETF Flow Data

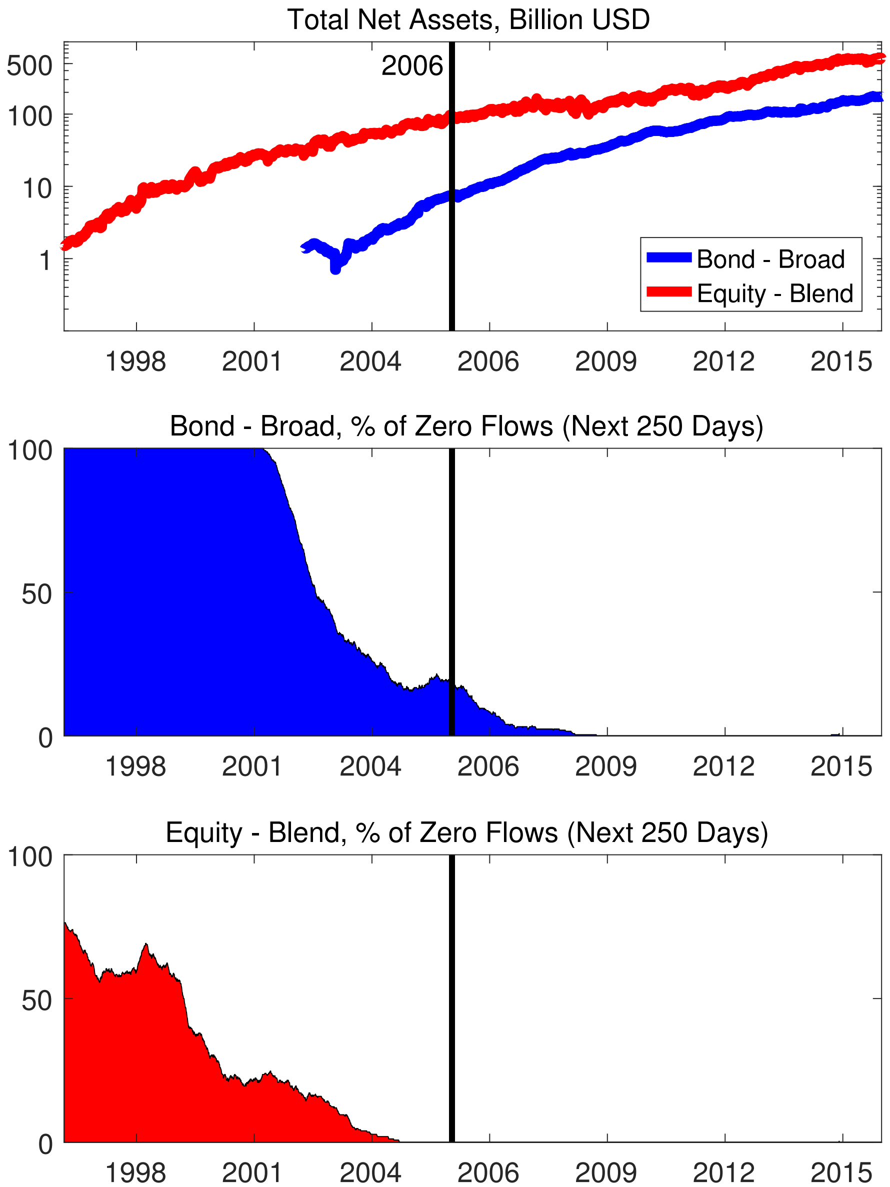


Table IA.1: Descriptive Statistics: Daily Fund Returns and Flows

This table reports descriptive statistics for daily ETF fund returns and ETF fund flows. "Equity" are funds from all U.S. Blend Equity categories according to the Morningstar fund classification. "Bond" are all funds from the U.S. Broad Bond and U.S. Government Bond categories according to the Morningstar fund classification. "Equity Premium" are equity minus bond returns and, analogously, "Risk Shifts" are the equity minus bond flows. 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 80 scheduled FOMC announcements in our sample period from 01/02/2006 to 12/30/2015. Flows are de-meaned and normalized by the lagged 250-day moving average and moving standard deviation (zero flow observations are left untouched). The fund data are obtained from Trimtabs.

	Returns, %			**Flows, %**		
	"Equity Premium" Equity-Bond	**Equity**	**Bond**	**"Risk Shift" Equity-Bond**	**Equity**	**Bond**
	All Observations					
mu	0.02	0.04	0.01	0.00	0.00	0.00
s.d.	1.42	1.33	0.23	1.42	0.96	0.97
vr_2	0.91	0.93	0.96	1.07	1.12	1.04
vr_5	0.79	0.81	0.86	1.24	1.17	1.27
vr_{10}	0.69	0.72	0.79	1.33	1.04	1.52
vr_{20}	0.65	0.68	0.85	1.52	0.93	1.86
#*zeros*	0	0	0	0	0	72
#*obs*	2516	2516	2516	2516	2516	2516
	FOMC Announcement Days (t=0)					
mu	0.47	0.51	0.04	0.03	0.29	0.26
s.d.	1.49	1.45	0.31	2.23	1.18	1.65
#*obs*	80	80	80	80	80	80

Table IA.2: Correlations of Factor Components

	$\triangle OIS(3M)$	$\triangle OIS(6M)$	$\triangle TS(2Y)$	$\triangle TS(5Y)$	$\triangle TS(10Y)$	$\triangle log(CDS)$	$\triangle log(DOL)$	$\triangle log\left(VIX^2\right)$	$\triangle log\left(TYVIX^2\right)$
	Autocorrelations								
$ac1$	0.03	-0.04	-0.06	-0.03	-0.02	0.17	0.03	-0.10	-0.01
$ac2$	0.03	0.00	-0.08	-0.08	-0.05	-0.05	0.01	-0.06	-0.05
$ac3$	0.05	0.02	0.02	0.03	0.02	0.01	0.02	-0.02	-0.05
$ac4$	0.06	-0.01	-0.02	-0.01	-0.01	0.03	0.04	-0.03	-0.06
$ac5$	0.10	0.10	-0.01	-0.03	-0.03	-0.04	-0.02	-0.05	-0.06
	Correlations FOMC Days \ All Days								
$\triangle OIS(3M)$	1.00	0.85	0.46	0.32	0.20	-0.16	0.00	-0.13	-0.10
$\triangle OIS(6M)$	0.93	1.00	0.52	0.37	0.25	-0.17	0.03	-0.15	-0.11
$\triangle TS(2Y)$	0.48	0.56	1.00	0.90	0.71	-0.23	0.00	-0.30	-0.07
$\triangle TS(5Y)$	0.22	0.27	0.88	1.00	0.92	-0.25	0.00	-0.32	0.04
$\triangle TS(10Y)$	0.07	0.10	0.72	0.94	1.00	-0.26	-0.02	-0.33	0.09
$\triangle log(CDS)$	-0.10	-0.07	-0.28	-0.36	-0.42	1.00	0.05	0.36	0.19
$\triangle log(DOL)$	0.16	0.26	0.53	0.59	0.49	-0.10	1.00	0.14	0.05
$\triangle log\left(VIX^2\right)$	-0.09	-0.04	-0.09	-0.04	-0.07	0.49	0.24	1.00	0.31
$\triangle log\left(TYVIX^2\right)$	0.06	-0.01	0.04	0.18	0.17	0.28	0.17	0.38	1.00

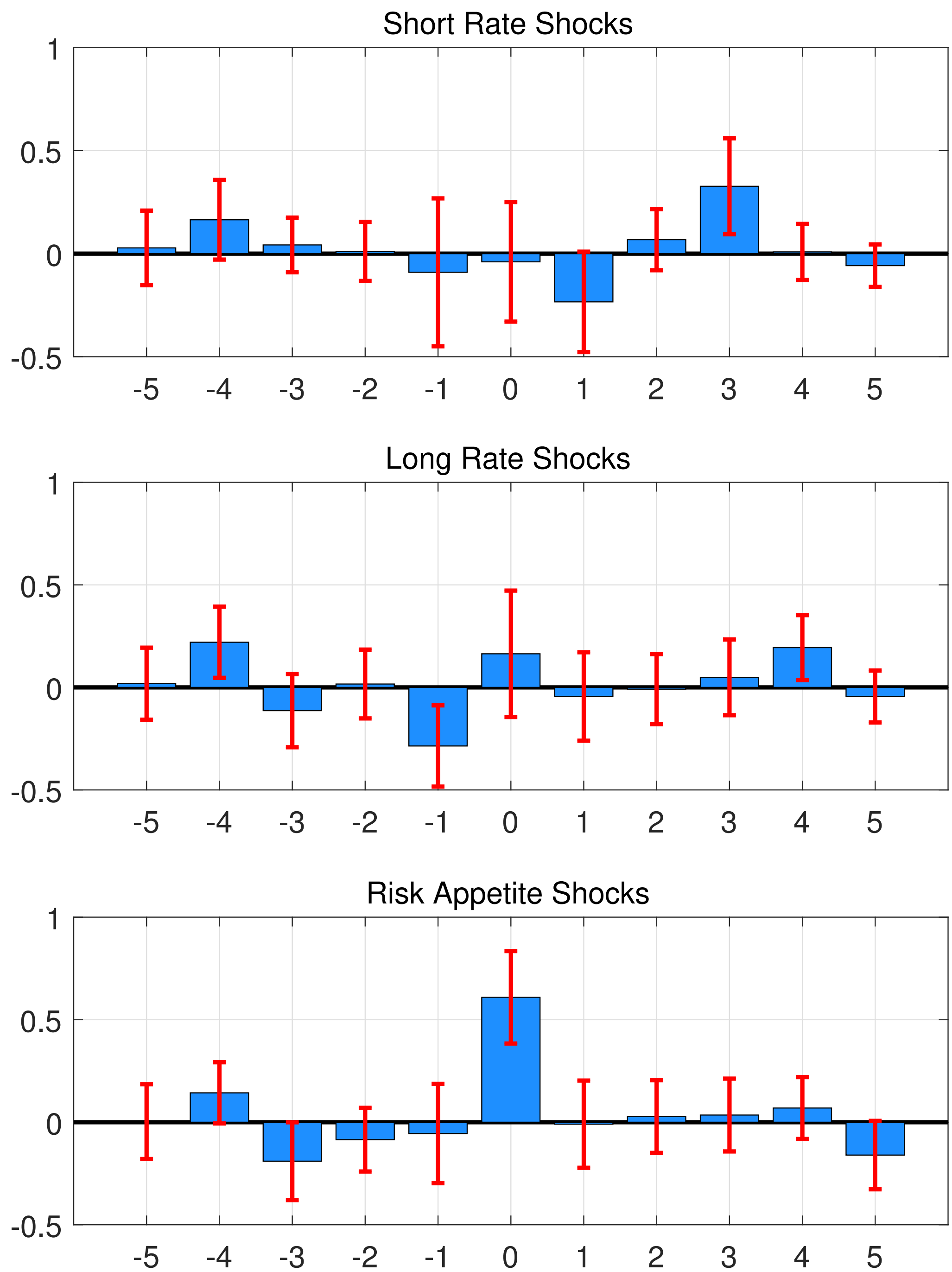
Table IA.3: Monetary Policy Shocks: Extended Sample (1996-2015)

Principal component analysis as in Table 1, but without $\triangle CDS$, $\triangle DOL$, and $\triangle TYVIX$ - the sample is extended to 1996 - 2015.

	Monetary Policy Shocks						
	PCA on FOMC Days (#160)			**Orthogonal Rotation**			
	(1)	**(2)**	**(3)**	**"Short Rate"**	**"Long Rate"**	**"Risk Appetite"**	$\frac{\sigma^2_{FOMC}}{\sigma^2_{All}}$
$\triangle OIS(3M)$	-0.30	-0.09	0.65	0.72*	-0.09	0.00	0.52
$\triangle OIS(6M)$	-0.41	-0.04	0.50	0.65*	0.10	0.00	0.68
$\triangle TS(2Y)$	-0.53	0.07	-0.09	0.19	0.50	0.04	0.85
$\triangle TS(5Y)$	-0.50	0.10	-0.26	0.02	0.57*	0.04	0.76
$\triangle TS(10Y)$	-0.44	0.22	-0.44	-0.17	0.64*	-0.04	0.73
$\triangle log\left(VIX^2\right)$	0.15	0.96	0.22	0.02	0.02	-1.00*	0.82
Var. expl.,%	90.53	6.96	2.24				

Figure IA.2: Average Monetary Policy Shocks Around FOMC Announcement Days

This figure shows average monetary policy shocks around FOMC announcement days (t=0) from t=-5 days to t=+5 days. Estimates are based on event window dummy regressions, the red lines represent HAC robust 90% confidence intervals. The sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.



Other days and announcements

Figures IA.3 and IA.4 show the reaction of equity excess returns (equity minus bond fund returns; blue) and risk shifts (equity minus bond fund flows; red) to risk appetite shocks on all days, excluding observations 5 days prior and up to 10 days after FOMC announcement days (FOMC period).

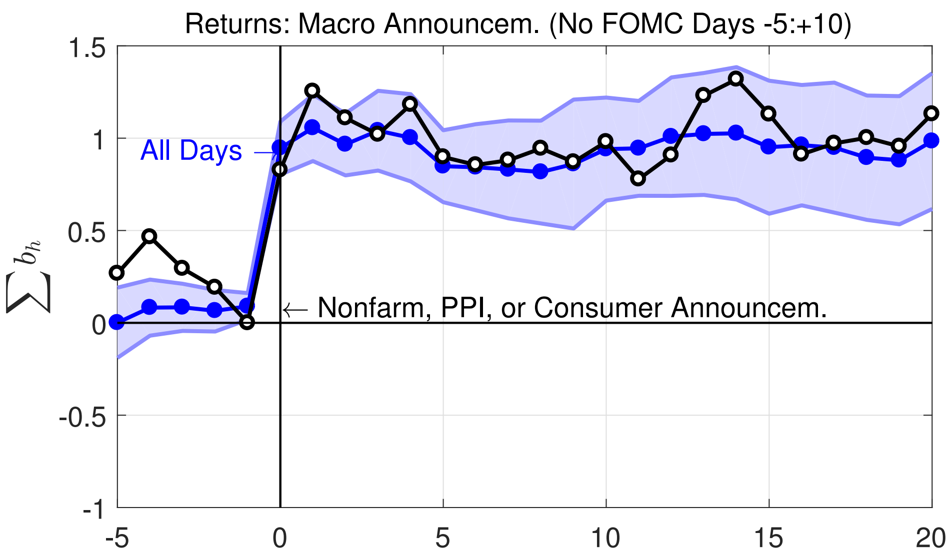
We find that returns are also sensitive to risk appetite shocks on other days. However, the return reaction is persistent. Moreover, we do not observe economically sizeable shifts from bonds to equities. We find that flows are on other days considerably less sensitive to risk appetite shocks than on FOMC days.

The black line in Figure IA.3 reports results for days that include a macroeconomic news announcement, i.e. nonfarm payrolls, the producer price index, or the consumer survey report (and fall not into the FOMC period). We do not find significant and economic sizeable differences to other days.

The black line in Figure IA.4 reports results for days that include an announcement by the ECB, Bank of England, or Bank of Japan (and fall not into the FOMC period). Again, we do not find significant and economic sizeable differences to other days.

Figure IA.3: Macro Announcements

In contrast to Figure 4 of the main paper, this figure shows the effect of risk appetite shocks on all days, excluding observations 5 days prior and up to 10 days after scheduled FOMC announcements (blue/red), i.e. approximately the half of the sample that is as far as possible away from scheduled FOMC announcements. The black line (with white dots) corresponds to macroeconomic news announcements (non-farm payroll/economic situation report, producer price index, and consumer survey report) where we apply the same sample exclusion restriction.



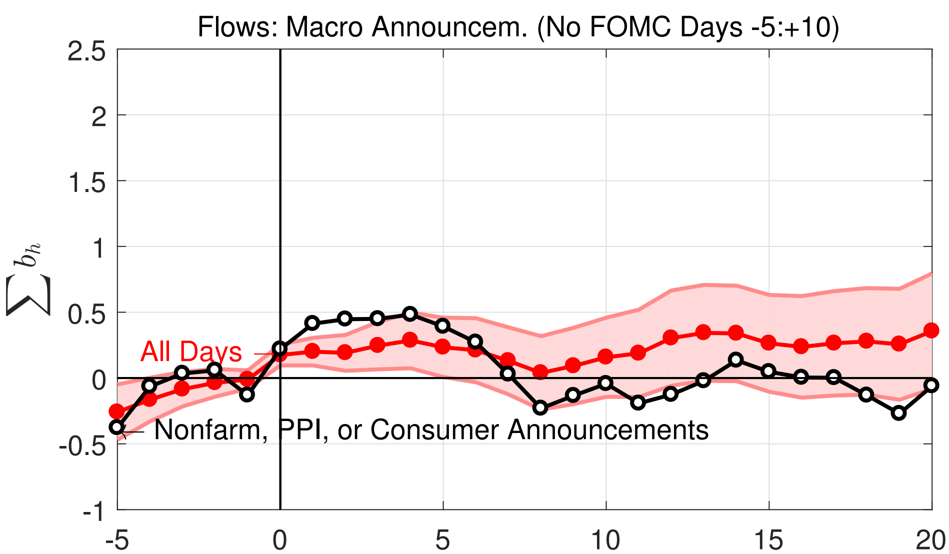
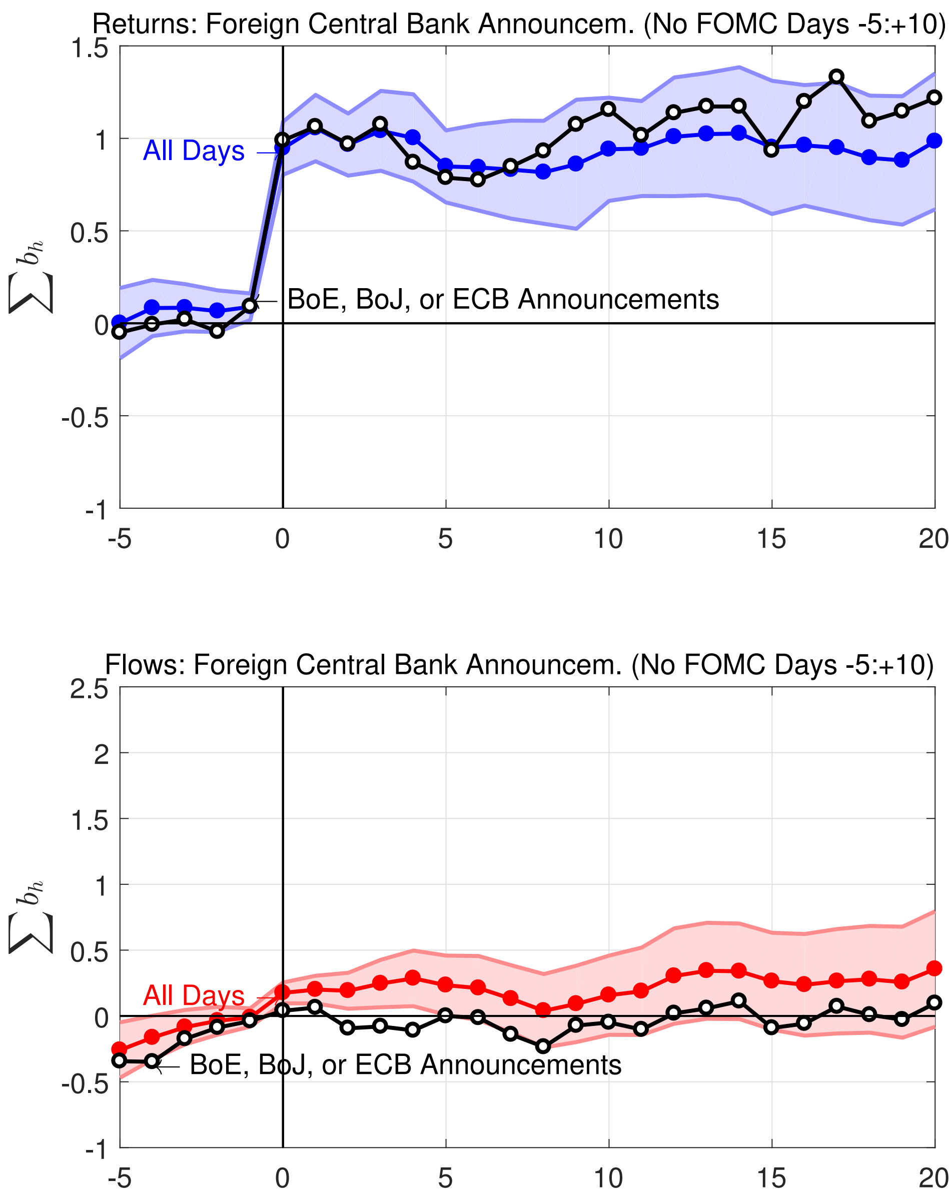


Figure IA.4: Foreign Central Bank Announcements

In contrast to Figure 4 of the main paper, this figure shows the effect of risk appetite shocks on all days, excluding observations 5 days prior and up to 10 days after scheduled FOMC announcements (blue/red), i.e. approximately the half of the sample that is as far as possible away from scheduled FOMC announcements. The black line (with white dots) corresponds to foreign central bank announcements (Bank of England, Bank of Japan, and the European Central Bank) where we apply the same sample exclusion restriction.



Further Results for Short & Long Rate Shocks

Figure IA.5 shows the response of equity excess returns and flows to short rate and long rate shocks on FOMC announcement days. These figures visualize the results from Table 4 in the main paper. Figure IA.6 provides results for a sample period extended to 1996. We find that results from the extended sample period, and a susample (1996-2005), are largely in line with our baseline results (2006-2015).

Figure IA.5: Short and Long Rate Shocks on FOMC Days

In contrast to Figure 4 of the main paper, this Figure provides results for the "short rate" (left) and the "long rate" (right) shocks. The y-axis is the same as in Figure 4 to facilitate comparisons.

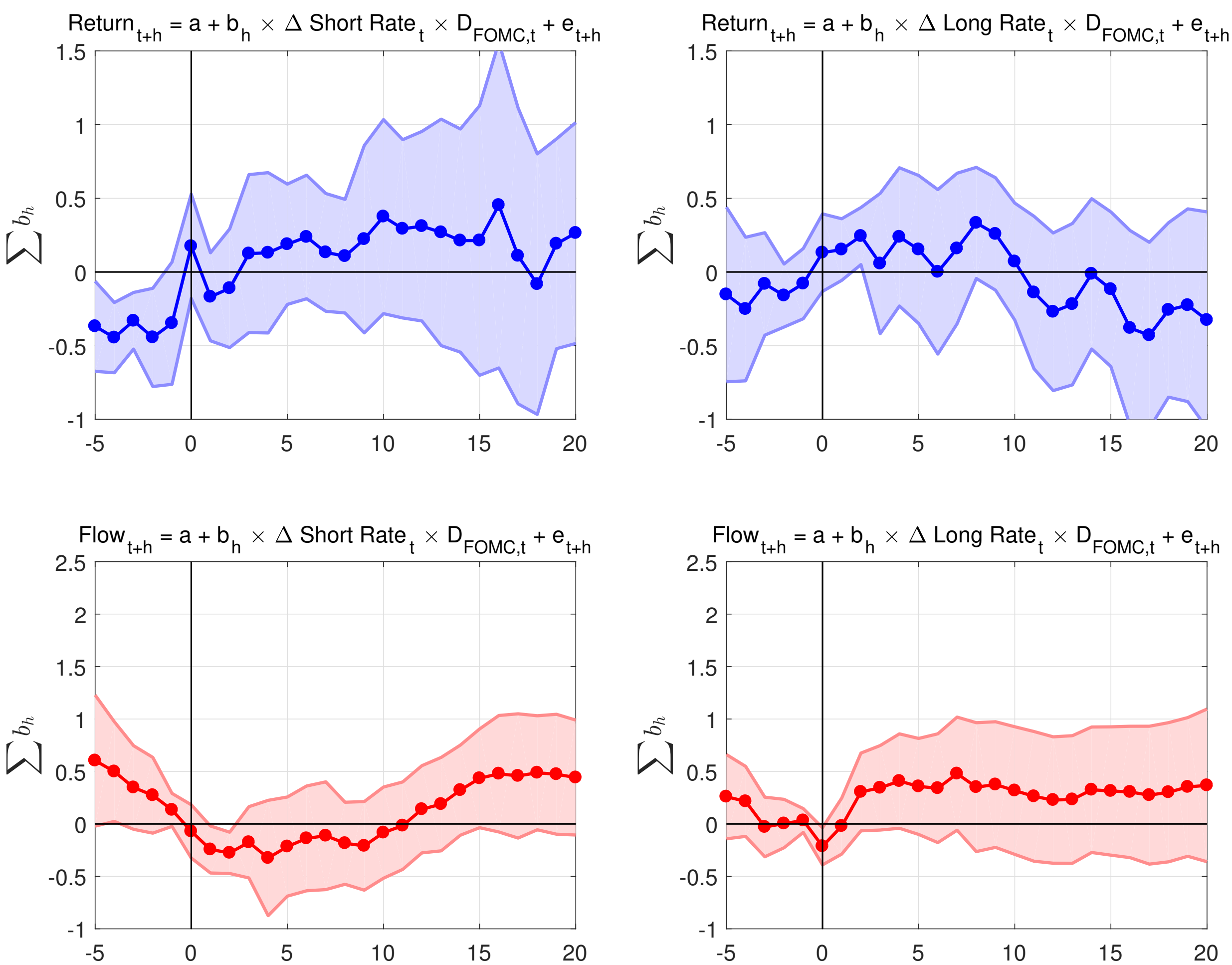
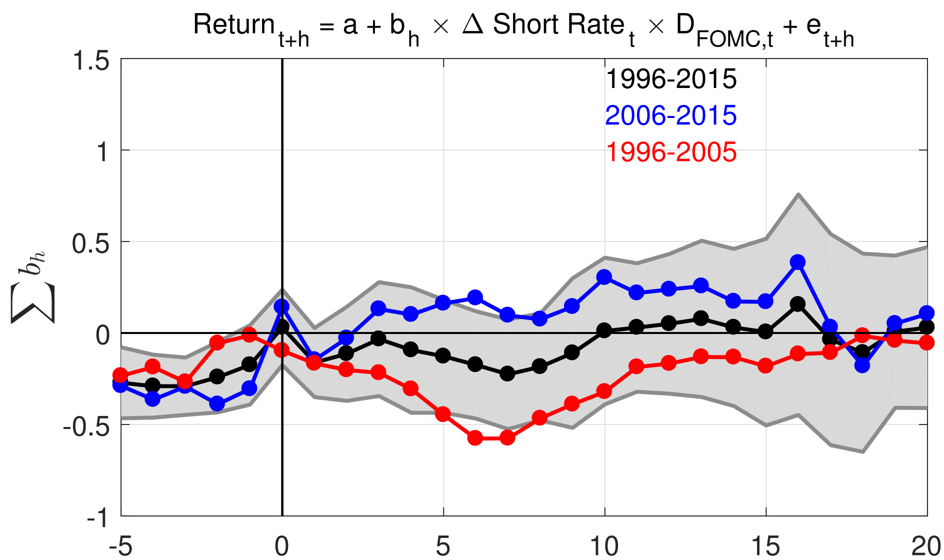
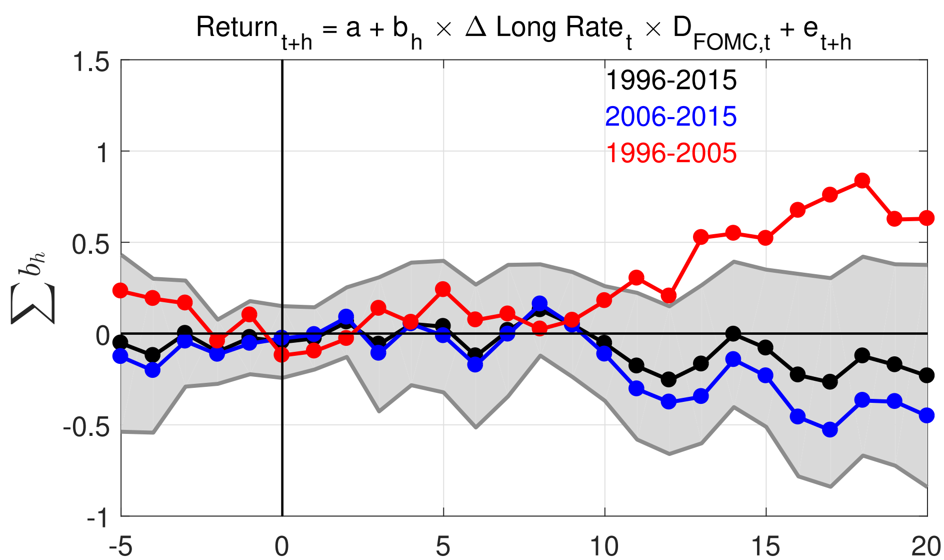


Figure IA.6: S&P 500 Excess Returns and Short / Long Rate Shocks on FOMC Days from 1996 - 2015

This figure provides results for S&P 500 returns and the "short rate" (top) and the "long rate" (bottom) factors for a sample period extended to 1996.





Equity risk factors and monetary policy shocks

Table IA.4 provides time-series regressions of the five Fama and French (2015)-factors on our three monetary policy shocks on FOMC announcement days. We add the short-term reversal premium as a 6th factor, as a proxy for the price of liquidity provision (we elaborate on this point in Section V). All factors are explained in more detail in the caption of the table; the data are taken from the website of Kenneth R. French and are based on CRSP.

Results for the market factor (CRSP market return over the short-term risk free rate) mirror the previous findings. The market excess return has a large (0.81%) and highly significant exposure to risk appetite shocks (t: 8.5), whereas the other two monetary policy shocks do not play a prominent role.

Regarding the remaining Fama and French (2015)-factors, we only find that the premium of small stocks over big stocks (SMB) and the premium of short-term losers over short-term winners (STR) have significant risk appetite loadings. However, all R^2 are low. It is also interesting to note, that the remaining factors do not seem to have very high average returns on FOMC announcement days. In unreported results, we also do not find significant flows from big to small stocks or from growth to value funds, which is in line with the presented evidence from prices. Put differently, there is a lack of cross-sectional return dispersion and hence no interesting variation to explain in this dimension.

Table IA.4: Monetary Policy Shocks and Equity Risk Factors

This table reports regression results of various equity factor premia on monetary policy shocks on FOMC days. The monetary policy shocks are short rate shocks (SR), long rate shocks (LR), and risk appetite shocks (RA), as described in Table 1. The equity premia are taken Kenneth R. French's website and include: Mkt-Rf - the return of the stock market minus the short-term risk free rate, SMB - the return of small stocks minus big stocks, HML - the return of value (high book-to-market ratio) stocks minus growth (low book-to-market) stocks, RMW - the return of profitable (reasonable) stocks minus unprofitable (weak) stocks, CMA - the return of stocks that invest conservative minus stocks that invest aggressive, and the short-term reversal (STR) - the return of past days loser stocks minus past days winner stocks. mu_{All} is the average return over all observations, mu_{FOMC} is the average return conditional on FOMC announcement days. T-statistics are HC robust. The sample period is from 2006 to 2015; 80 scheduled FOMC announcements.

	Fama-French Factors and Monetary Policy Shocks on FOMC Days					
$R_{t\|FOMC}$	**Mkt-Rf**	**SMB**	**HML**	**RMW**	**CMA**	**STR**
	Average Returns, FOMC Days vs All Days					
$mu_{All} \times 10000$	3.32	0.44	-0.40	1.21	0.32	2.83
$mu_{FOMC} \times 10000$	51.64	3.20	16.30	-11.14	-9.96	17.96
	$R_{t\|FOMC} = a + b_{SR}SR_{t\|FOMC} + b_{LR}LR_{t\|FOMC} + b_{RA}RA_{t\|FOMC} + \xi_{t\|FOMC}$					
$a \times 10000$	6.25	-7.15	20.02	-8.70	-8.05	1.77
t	0.58	-0.93	1.96	-1.84	-2.61	0.23
b_{SR}	0.14	-0.04	0.04	0.00	-0.03	-0.10
t	2.17	-0.87	0.68	-0.09	-1.00	-0.73
b_{LR}	-0.05	-0.01	-0.13	0.04	-0.03	-0.01
t	-0.46	-0.18	-1.10	1.33	-1.71	-0.10
b_{RA}	0.81	0.17	-0.02	-0.05	-0.03	0.26
t	8.45	3.34	-0.33	-1.34	-1.49	2.85
$R^2, \%$	53.56	11.01	8.05	5.75	6.56	12.68
	$R_{t\|FOMC} = a + b_{RA}RA_{t\|FOMC} + \xi_{t\|FOMC}$					
$a \times 10000$	3.76	-6.69	17.57	-8.04	-8.08	2.99
t	0.35	-0.88	1.81	-1.73	-2.58	0.34
b_{RA}	0.82	0.17	-0.02	-0.05	-0.03	0.26
t	8.38	3.26	-0.35	-1.29	-1.35	3.08
$R^2, \%$	49.61	9.61	0.10	2.50	1.97	9.97

Details on the return decomposition

Campbell and Shiller (1988) 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 inspected in Table IA.5.

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 backout 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 $-\eta_{d,t+1}$, and hence we run the linear projections:

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

and plot these in Figure 6. 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 shocks.

Table IA.5: 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), 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" ($\times - 1$) is then used in Figure 5 as a dependent variable. The data are daily and the sample period is from January 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}
$Ret_t - Rf_t$	-0.07	0.00	0.02	0.00
EP_t	14.66	0.91	-4.55	-0.40
$VIX_t^2 - RV_t^2$	0.65	0.00	0.74	-0.02
DP_t	-0.23	0.00	0.07	1.00
$t(Ret_t - Rf_t)$	-2.61	0.83	5.07	2.26
$t(EP_t)$	2.50	32.44	-5.82	-2.36
$t(VIX_t^2 - RV_t^2)$	3.22	-3.03	26.25	-3.12
$t(DP_t)$	-0.80	2.15	2.55	128.57
F, pv	0.00	0.00	0.00	0.00
R^2, %	2.76	94.65	80.25	98.88
$Var(CF)$	27.56			
$Var(DR)$	31.39			
$Cov(DR, CF)$	-20.52			

Reduced-form asset pricing

Our results on ETF flows indicate that investors care a lot about key monetary policy events. And, they suggest that it is primarily monetary policy induced shocks to risk appetite that act as triggers for investors' portfolio rebalancing decisions. Equipped with these findings, we now turn to some asset pricing tests, based on reduced form models with a risk appetite factor.

The asset pricing model we test is:

$$E\left(R_{i,t}|FOMC\right) = \lambda_{RA}\tilde{\beta}_{i,RA},$$

where $E\left(R_{i,t}|FOMC\right)$ is the expected return of asset class i on FOMC announcement days, $\tilde{\beta}_{i,RA}$ is the loading on risk appetite shocks on FOMC announcement days and is obtained from a first-step time-series regression, λ_{RA} is the factor risk price and is obtained from cross-sectional Fama and MacBeth (1973) regressions.[23] The test assets are based on our fund data and are the returns of a large cross-section of seven bond fund categories and seven equity fund categories.[24]

Panel A of Table IA.6 provides the cross-sectional Fama-MacBeth estimates. The price of risk appetite is 58bp with a t-statistic of 2.8. Moreover, as indicated by the large cross-sectional R^2 of 95%, the single factor model based on risk appetite can also explain the returns of (almost) all other asset classes on FOMC days. This finding mirrors Savor and Wilson (2014), who find that the market return explains many asset returns on FOMC days (but not on other days).

Panel B of Table IA.6 shows that with loadings around 1.0, blend, value, growth, big, and small equities all load similarly on this risk appetite - only emerging market equity has a rather high loading of 1.5. Risk appetite do not drive the value premium or the size premium. With regard to the bond categories, we find loadings on risk appetite are increasing with the risk spectrum. Short maturity bonds have tiny loadings, 0.03, corporate bonds 0.17, and high yield, developed market, and emerging market bonds have loadings above 0.30. All in all, we find large variation in risk loadings across the different assets.

Figure IA.7 plots the model-implied against the realized average FOMC returns. With the exception of developed market bonds, all average returns lie on, or very close to 45 degree line. The figure also provides a plot of realized average returns on all days, that is, when the model is re-estimated on all observations (including FOMC announcement days). This plot shows two clusters, one captures the bond returns and the other the equity returns. Both clusters centre around the diagonal line. However, within each cluster, there are rather large deviations from the diagonal line.

[23]We include a constant (common pricing error) to the regression model and correct Fama and MacBeth (1973)-standard errors for heteroscedasticity. Notice that the panel is unbalanced, which means that we cannot apply Shanken (1992)-corrections.

[24]More specifically, we use the Morningstar classification to group all funds into the categories 1) broad bond market, 2) broad bond market - short maturity , 3) broad bond market - intermediate/long maturity, 4) corporate bond, 5) high yield bond, 6) developed market bond, 7) emerging market bond, 8) blend equity, 9) value equity, 10) growth equity, 11) big equity, 12) small equity, 13) developed market equity, and 14) emerging market equity. Categories 1), 4), 5), 6), 7), 8), and 14) are exactly the funds as identified in the previous tables.

Table IA.6: Reduced Form Pricing of 14 Asset Classes on FOMC Announcement Days

This table reports reduced-form asset pricing tests for the model:

$$E\left(R_{i,t}|FOMC\right) = \lambda_{\triangle RA}\hat{\beta}_{i,\triangle RA},$$

where $E\left(R_{i,t}|FOMC\right)$ is the expected return of asset class i on FOMC announcement days, $\lambda_{\triangle RA}$ is the price of risk appetite shocks, and $\hat{\beta}_{i,\triangle RA}$ is the factor loading of asset class i to risk shocks on FOMC announcement days. Panel A reports second-pass cross-sectional Fama-MacBeth estimates for $\lambda_{\triangle RA}$, the cross-sectional R^2_{CS}, the mean absolute error (MAE), and the root mean squared error ($RMSE$). The test assets are 14 asset classes: 7 bond categories and 7 equity categories, as described in the text. The first-pass time-series regression estimates of $\hat{\beta}_{i,\triangle RA}$ are reported in Panel B. R^2_{TS} is the coefficient of determination in the time-series regression, $\bar{R}$ is the average return, and $E(R)$ is the expected return as predicted by the model for asset class i. The data are daily and the sample period is from 2006 to 2015.

Panel A: Cross-Section FOMC Days

	FMB
const.	2.73
t	1.39
$\lambda_{\triangle RA}$	57.68
t	2.75
R^2_{CS}	0.95
MAE	3.67
$RMSE$	5.90
#Obs.	80

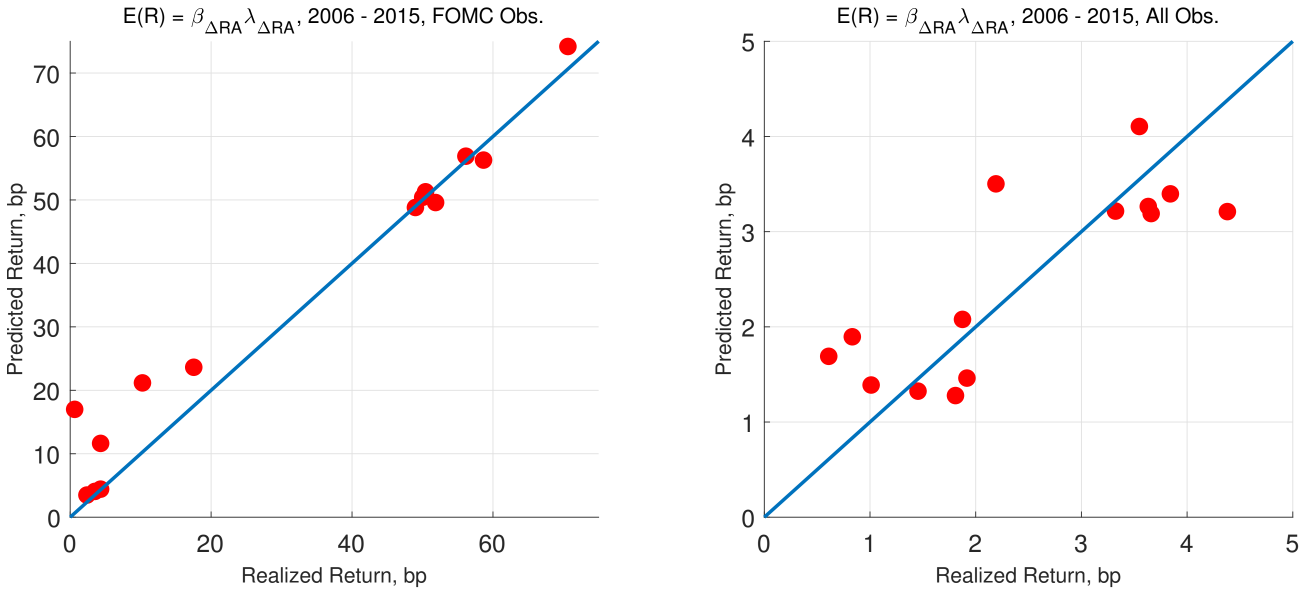
Panel B: Time-Series FOMC Announcement Days

	Bonds						
	Broad	**Short**	**Long**	**Corp**	**HY**	**DM**	**EM**
a	0.02	0.02	0.03	-0.02	0.02	-0.10	-0.03
t	0.57	1.07	0.47	-0.31	0.37	-1.35	-0.51
$\beta_{\triangle RA}$	0.02	0.01	0.03	0.15	0.36	0.25	0.32
t	0.70	0.73	0.63	2.47	5.30	3.85	4.22
R^2_{TS}	0.01	0.01	0.01	0.19	0.50	0.34	0.46
$\bar{R} \times 10000$	3.60	2.47	4.41	4.41	17.63	0.73	10.35
$E(R)$	3.96	3.39	4.32	11.53	23.53	16.89	21.06
#Obs.	80	80	80	48	48	44	44

	Equities						
	Blend	**Value**	**Growth**	**Big**	**Small**	**DM**	**EM**
a	0.01	0.02	0.04	0.02	0.01	0.04	-0.02
t	0.11	0.14	0.45	0.23	0.09	0.43	-0.12
$\beta_{\triangle RA}$	0.84	0.83	0.81	0.80	0.94	0.93	1.24
t	8.30	7.94	8.80	8.55	7.77	8.34	8.71
R^2_{TS}	0.50	0.46	0.52	0.51	0.46	0.52	0.48
$\bar{R} \times 10000$	50.52	50.12	51.95	49.09	56.25	58.75	70.73
$E(R)_{FMB}$	51.18	50.31	49.49	48.71	56.79	56.18	74.08
#Obs.	80	80	80	80	80	80	80

Figure IA.7: Cross-Sectional Asset Pricing

This figure plots predicted average returns (in basis points) versus realized average returns of the 14 asset classes reported in Table IA.2. The only risk factor are "risk appetite shocks". The left figure provides results for average returns on FOMC announcement days, the right figure reports results for all available observations (including the FOMC days). The sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.



Mutual Funds - Slow Money

Figure IA.8 shows the effect of risk appetite shocks on mutual fund returns and flows. As can be expected, mutual fund returns show the same reaction to risk appetite shocks as the market or ETF fund returns. However, we do not find any effect on mutual fund flows. This is hardly surprising. Because of their fairly high transaction costs (front-end fees, but also buying/selling restrictions for large block investors) mutual fund flows are not well suited for short-horizon asset re-allocations.

Figure IA.8: Slow Money and Risk Appetite Shocks

In contrast to Figure 4, ETF flows and returns are replaced by mutual fund flows and returns. Estimates are scaled such that they show the effect of a one standard deviation risk shock on FOMC announcement days. The shaded area represents HAC robust 90% confidence intervals. Flows and returns are measured daily (close-to-close); the sample period is from 2006 to 2015; 2516 observations with 80 scheduled FOMC announcements.