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# Monetary Momentum

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## Abstract

We document a large return drift around monetary policy announcements by the Federal Open Market Committee (FOMC). Stock returns start drifting up 25 days before expansionary monetary policy surprises, whereas they decrease before contractionary surprises. The cumulative return difference across expansionary and contractionary policy decisions amounts to 2.5% until the day of the policy decision and continues to increase to more than 4.5% 15 days after the meeting. The drift is more pronounced during periods of high uncertainty, it is a market-wide phenomenon, and it is present in all industries and many international equity markets. Standard returns factors and time-series momentum do not span the return drift around FOMC policy decisions. A simple trading strategy exploiting the drift around FOMC meetings increases Sharpe ratios relative to a buy-and-hold investment by a factor of 4. The cumulative returns before FOMC meetings significantly predict the subsequent policy *surprise*.

**JEL classification:** E31, E43, E44, E52, E58, G12

**Keywords:** Return Drift, Monetary Policy, FOMC, Macro News

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# I Introduction

Figure 1 documents a novel fact for stock returns around monetary policy decisions by the Federal Open Market Committee (FOMC): starting around 25 days before the FOMC meeting, returns of the Center for Research in Security Prices (CRSP) value-weighted index drift upwards before expansionary monetary policy decisions (lower-than-expected federal funds target rates) and drift downwards before contractionary policy decisions. The difference in returns between expansionary and contractionary policy surprises amounts to 2.5% until the day before the announcement. On the day before the announcement, returns drift upwards independent of the direction of the monetary policy surprise, which is the pre-FOMC announcement drift of Lucca and Moench (2015). Around the announcement, contractionary monetary policy surprises result in negative returns, and expansionary surprises result in an increase in returns, consistent with a large literature, such as Bernanke and Kuttner (2005). Returns, however, continue to drift in the same direction for another 15 days, which – together with the long pre-drift – is the novel fact we document in this paper.

The continuation in returns is surprising, because the trading signal it builds on is publicly observable. On average, the difference in the drift from before until after the announcement across contractionary and expansionary surprises amounts to around 4.5%, which is large relative to an annual equity premium of 6%. We label the return drift around monetary policy decisions *monetary momentum*.<sup>1</sup>

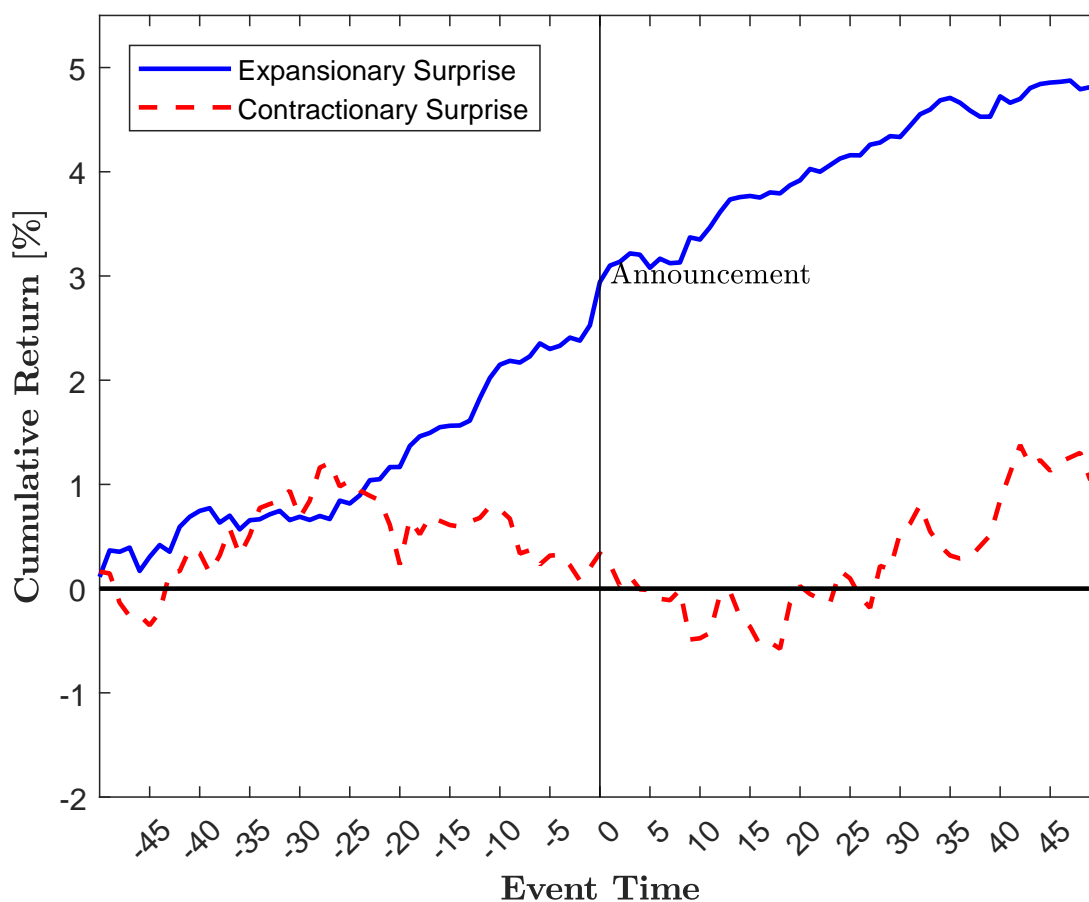
Our findings have important implications for policy and research. First, a recent literature studies the effect of monetary policy on asset prices, using narrow event windows of 30 or 60 minutes around FOMC policy decisions to obtain identification. The large drift before and after FOMC decisions suggests researchers might underestimate the effect of monetary policy on asset prices by restricting attention to narrow event windows. Second, the magnitude of the drift around FOMC decisions suggests asset pricing theories that aim to understand the unconditionally large excess returns of stocks relative to bonds should focus on channels through which monetary policy and asset markets interact. Third, the pre-drift around FOMC decisions implies “surprise changes” in target rates

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<sup>1</sup>We discuss the statistical significance below.

might partially be predictable, which has important implications for the large literature in macroeconomics and monetary economics that tries to understand the real effects of *exogenous* monetary policy *shocks* on real consumption, investment, and GDP. In fact, we document later in the paper that the cumulative return drift before FOMC announcement significantly predicts the subsequent monetary policy surprise.

Figure 1: Cumulative Returns around FOMC Policy Decisions



*This figure plots cumulative returns in percent around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. The sample period is from 1994 to March 2019 excluding the months from January 2010 until November 2015.*

Our baseline sample runs from 1994, when the FOMC started issuing press releases after meetings and policy decisions, until 2019 excluding the months from January 2010 until November 2015 during which the zero-lower bound (ZLB) on nominal interest was binding. The differential drift around contractionary and expansionary FOMC

announcements is a robust feature of the data. The differential return drift across expansionary and contractionary periods is present both before ZLB started binding in a sample until December 2009 and after the liftoff from 0 in December 2015. It also holds for samples with or without intermeeting policy decisions (policy decisions on unscheduled FOMC meetings), with or without turning points in monetary policy (changes in the federal funds target rate in the direction opposite to the previous move), or how we treat zero-changes in the federal funds target rate (typically FOMC meetings on which the target rate does not change).

We define expansionary and contractionary monetary policy shocks using federal funds futures (Kuttner (2001) surprises). Lower-than-expected federal funds target rates (expansionary monetary policy surprises) do not necessarily coincide with cuts in the target rate. The market might assign a probability of less than 100% to a cut in target rates, and we would measure expansionary surprises whenever the FOMC indeed lowers target rates. But we would also measure an expansionary monetary policy surprise if the market assigns a positive probability to a tightening in target rates that does not materialize. We do not find similar return drifts when we sort on raw changes in the target rate. Instead, the FOMC seems to increase rates following positive stock returns and cut rates after negative stock returns, consistent with the idea of a *Greenspan Put* (see Cieslak, Morse, and Vissing-Jorgensen (2019) and Cieslak and Vissing-Jorgensen (2017)).

Market participants cannot observe whether target-rate changes are expansionary or contractionary according to our definition until after the actual change in target rates. The differential drift following expansionary versus contractionary policy shocks is still economically large and statistically significant when we start the event window on the *day after* the FOMC policy decision.

The pre- and post-drifts are largely a market-wide phenomenon. We do not find similar return drifts around FOMC announcements for cross-sectional return premia, such as size, value, profitability, or investment, because all portfolios tend to drift in the same direction. Beta-sorted portfolios are an exception: high-beta stocks experience a differential return drift across expansionary and contractionary policy surprises that amounts to 9%, whereas low beta stocks have only a drift of around 3% consistent with

the results in Savor and Wilson (2013, 2014) who find the CAPM tends to hold around macroeconomic announcements.

We find drift behavior similar to the drift for the overall market at the industry level when we study returns following the Fama & French 17-industry classification with a return-drift difference of around 4% around expansionary versus contractionary monetary policy surprises. *Machinery* is an exception, with a return drift of almost 8%, and *Mining*, with no differential return drift at all because mining stocks appreciate following contractionary monetary policy.

The return drift is not contained to the United States, but also occurs in international equity markets. We find a differential return drift for benchmark equity indexes around U.S. monetary policy decisions for Germany, Canada, French, Spain, Switzerland, and the U.K. with magnitudes that are comparable to the pattern in the United States. We find in untabulated results that Japan is an exception, because returns are flat for both U.S. contractionary and expansionary monetary policy surprises similar to the non-existent pre-FOMC announcement drift for Japan in Lucca and Moench (2015).

We compare the Sharpe ratios of monetary momentum strategies with the Sharpe ratios of a buy-and-hold investor to gauge the economic significance of the return drift around FOMC meetings. We find increases in Sharpe ratios by a factor of four for a simple monetary momentum strategy that investors can implement in real time relative to buy and hold. We also find standard return factors cannot span our monetary momentum strategy with a large unexplained return of 13% per year. Recently, Moskowitz, Ooi, and Pedersen (2012) popularized time-series momentum strategies. We show time-series momentum and monetary momentum are economically distinct phenomena.

Predictability and persistence in the monetary policy shocks themselves might drive the return drift we uncover. We find expansionary surprises follow contractionary and expansionary surprises with equal probabilities, and the sign of past surprises cannot predict the sign of current surprises. These patterns in policy surprises mean persistent shocks and predictability in monetary policy shocks by past shocks are unlikely to explain our results.

Another possible explanation might be state dependence of monetary policy shocks.

The FOMC might surprisingly cut rates in times of high risk or risk aversion, which could possibly explain the upward drift around events we associate with expansionary shocks. Consistent with this idea, monetary policy shocks are on average more expansionary in periods of high uncertainty and we document that the level of the VIX 15 days before the FOMC announcement relative to the 5 year moving average level determines the differential return drift. If the VIX is above the historical average, the return drift amounts to 8% until 15 days post FOMC meeting. If instead the meeting occurs in a period with low levels of VIX, no significant differential return drift occurs. These results are consistent with Neuhierl and Weber (2019) who show the pre-FOMC announcement drift of Lucca and Moench (2015) in the 24 hours before FOMC decisions is fully contained during periods of high uncertainty.

## **A. Related Literature**

A large literature at the intersection of macroeconomics and finance investigates the effect of monetary policy shocks on asset prices in an event-study framework. In a seminal study, Cook and Hahn (1989) use daily event windows to examine the effects of changes in the federal funds rate on bond rates. They show changes in the federal funds target rate are associated with changes in interest rates in the same direction, with larger effects at the short end of the yield curve. Bernanke and Kuttner (2005)—also using a daily event window—focus on unexpected changes in the federal funds target rate. They find that an unexpected interest-rate cut of 25 basis points leads to an increase in the CRSP value-weighted market index of about 1 percentage point. Gürkaynak, Sack, and Swanson (2005) focus on intraday event windows and find effects of similar magnitudes for the S&P500. They argue that two factors, a target and path factor, are necessary to describe the reaction of notes with up to ten-year maturity to monetary policy shocks. Boyarchenko, Haddad, and Plosser (2017) extend the heteroskedasticity-based identification of Rigobon and Sack (2003) and also argue that two shocks best describe the reaction of financial instruments across a wide range of asset markets: a conventional monetary policy shock and a confidence shock. Leombroni, Vedolin, Venter, and Whelan (2019) decompose monetary policy shocks into a target and communication shock, and find the latter is

the main driver of yields around policy decisions. Neuhierl and Weber (2019) show the whole future path of monetary policy matters for the association between stock returns and federal funds rate changes. Boguth, Grégoire, and Martineau (2019) show the market expects monetary policy actions in recent years only on FOMC meetings with subsequent press conferences. Ozdagli and Weber (2019) use spatial autoregressions to decompose the overall response of stock returns to monetary policy surprises into direct demand effects and higher-order network effects, and find that more than 50% of the overall market response comes from indirect effects. Fontaine (2016) estimates a dynamic term-structure model and finds that uncertainty about future rate changes is cyclical. Law, Song, and Yaron (2018) document cyclical variation in the sensitivity of stock returns to monetary policy shocks. Ozdagli and Velikov (2020) use observable firm characteristics to construct a monetary policy exposure index to measure a monetary policy risk premium from the cross section of stock returns. Drechsler, Savov, and Schnabl (2018) provide a framework to rationalize the effect of monetary policy on risk premia. Schmeling and Wagner (2019) find the tone of policy releases moves asset markets and Kroencke et al. (2019) document a risk shift in fund allocations following FOMC decisions.

Besides the effect on the level of the stock market, researchers have recently also studied cross-sectional differences in the response of stocks to monetary policy. Ehrmann and Fratzscher (2004) and Ippolito, Ozdagli, and Perez-Orive (2018), among others, show that firms with high bank debt, firms with low cash flows, small firms, firms with low credit ratings, firms with low financial constraints, firms with high price-earnings multiples, and firms with Tobin's  $q$  show a higher sensitivity to monetary policy shocks, which is in line with bank-lending, balance-sheet, and interest-rate channels of monetary policy. Gorodnichenko and Weber (2016) show that firms with stickier output prices have more volatile cash flows and high conditional volatility in narrow event windows around FOMC announcements. Weber (2015) studies how firm-level and portfolio returns vary with measured price stickiness, and shows that sticky-price firms have higher systematic risk and are more sensitive to monetary policy shocks.

Another recent strand focuses on the effect of US monetary policy on other asset classes. Brooks, Katz, and Lustig (2018) study the drift in Treasury markets after

changes in fed fund target rates, Mueller, Tahbaz-Salehi, and Vedolin (2017) find a trading strategy short the US dollar and long other currencies earns substantially higher excess returns on FOMC announcement days, Wiriadinata (2018) shows unexpected cuts in fed funds target rates lead to larger currency appreciation of countries with larger US dollar denominated net external debt, Karnaukh (2018) documents the U.S. dollar appreciates in the two-day window before contractionary monetary policy decisions and depreciates before expansionary policy decisions and Zhang (2019) shows the invoicing currency is an important determinant of international spillovers of monetary policy.

We also contribute to a recent literature studying stock return patterns around FOMC announcements. The most closely related paper is Lucca and Moench (2015), who show that 60% to 80% of the realized equity premium since 1994 is earned in the 24 hours *before* the actual FOMC meeting. Their pre-FOMC announcement drift is independent of the sign of monetary policy shocks and is contained in the 24 hours before the policy decision. Savor and Wilson (2013) show stock returns are substantially higher on macroeconomic announcement days such as FOMC days and Savor and Wilson (2014) find the CAPM tends to hold on these days. Brusa, Wilson, and Savor (2018) document a global FOMC announcement drift around the world that is unique to announcements of the FOMC compared monetary policy decisions of other central banks around the globe. Ai and Bansal (2018) develop a theory to rationalize macroeconomic announcement premia and pre-drifts such as the pre-FOMC announcement drift. Laarits (2019) distinguishes between Fed information effects (Paul (2019)) and conventional monetary policy news and develops a model in which the pre-FOMC announcement drift occurs because of resolution of uncertainty about announcement type. Hu et al. (2019) extend the pre-FOMC announcement drift to other macroeconomic announcements and develop a theory arguing “heightened uncertainty” in anticipation of pre-scheduled announcements drive the drift consistent with our heterogeneous results by the levels of VIX and the results in Neuhierl and Weber (2019).

We build on Lucca and Moench (2015) and show that a *differential* drift exists starting 25 days before the FOMC meeting and continuing for 15 days subsequent to the policy decision. This line of research focuses on patterns in stock returns independent of

the sign of the monetary policy shock. We build on this body of work and document an extended pre- and post-FOMC drift that has signs opposite to the surprises in line with the event-study literature we cite above: negative, that is, expansionary monetary policy shocks result in an upward drift in stock returns after as well as *before* the rate changes.

Moreover, the paper relates to the literature on the post-earnings-announcement drift (PEAD). Ball and Brown (1968) first document PEAD, which describes the tendency of stock returns to drift in the direction of recent earnings' surprises. Fama (1998) points out that PEAD has undergone heavy scrutiny and holds up out of sample and is therefore "above suspicion." Livnat and Mendenhall (2006) show the robustness of PEAD to different ways of measuring surprises and also provide a nice overview of the literature. PEAD is, however, concentrated in smaller firms, which raises concerns of its exploitability (see, e.g., Chordia et al. (2009)). We document a drift in returns around FOMC decisions in the direction opposite of the monetary-policy surprises. The drift occurs for market-wide indices and industry portfolios and is therefore not subject to high transaction costs. In addition, FOMC decisions during our sample period are pre-scheduled and closely watched, which makes inattention unlikely to drive our findings.

Finally, our findings are reminiscent of, but distinct from, the time-series momentum strategy of Moskowitz, Ooi, and Pedersen (2012), who document that aggregate indices that did well over the previous 12 months positively predict future excess returns for up to 12 months. Hence, our results provide *out-of-sample* findings to test behavioral theories of momentum, such as Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999) against rational theories, such as Berk, Green, and Naik (1999), Ahn, Conrad, and Dittmar (2003), and Sagi and Seasholes (2007).<sup>2</sup>

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<sup>2</sup>Of course a large literature also exists on cross-sectional momentum, that is, comparing the past performance of securities relative to the past performance of other securities. See, for example, Jegadeesh and Titman (1993) for U.S. equities, Moskowitz and Grinblatt (1999) for industries, Asness, Liew, and Stevens (1997) for equity indices, Shleifer and Summers (1990) for currencies, Gorton et al. (2013) for commodities, and Asness, Moskowitz, and Pedersen (2013) for evidence across asset classes and around the world.

## II Data

### A. Stock Returns

We sample daily returns for the CRSP value-weighted index directly from CRSP. The index is an average of all common stocks trading on NYSE, Amex, or Nasdaq. We also sample returns for international stock indices from Datastream. Industry and factor returns are from the Ken French data library and we construct daily value-weighted beta-sorted portfolios following the Fama & French convention of sorting portfolios annually at the end of June each year, keeping constant the portfolio assignment for 12 months using five years of monthly data to estimate betas.

### B. Federal Funds Futures Data

Federal funds futures started trading on the Chicago Board of Trade in October 1988. These contracts have a face value of \$5,000,000. Prices are quoted as 100 minus the average daily federal funds rate as reported by the Federal Reserve Bank of New York. Federal funds futures face limited counterparty risk due to daily marking to market and collateral requirements by the exchange. We use tick-by-tick data of the federal funds futures trading on the Chicago Mercantile Exchange (CME) Globex electronic trading platform (as opposed to the open outcry market) directly from the CME. Using Globex data has the advantage that trading in these contracts starts on the previous trading day at 6.30 pm ET (compared to 8.20am ET in the open outcry market). We are therefore able to calculate the monetary policy surprises for all event days including the intermeeting policy decisions occurring outside of open outcry trading hours.

Our sample period starts in 1994 and ends in March 2019. With the first meeting in 1994, the FOMC started to communicate its decision by issuing press releases after meetings and policy decisions. We do not include FOMC meetings during the liquidity trap period during which the ZLB on nominal interest rates was binding with no variation in federal funds futures-implied rates and no change in target rates until the liftoff from

the ZLB in December 2015.<sup>3</sup> The FOMC has eight scheduled meetings per year and, starting with the first meeting in 1994, most press releases are issued around 2:15 pm ET.

We now define the measure of monetary policy shocks following Kuttner (2001), Bernanke and Kuttner (2005), and Gürkaynak, Sack, and Swanson (2005). Let  $ff_{t,0}$  denote the rate implied by the current-month federal funds futures on date  $t$  and assume that one FOMC meeting takes place during that month.  $t$  is the day of the FOMC meeting and  $D$  is the number of days in the month. We can then write  $ff_{t,0}$  as a weighted average of the prevailing federal funds target rate,  $r_0$ , and the expectation of the target rate after the meeting,  $r_1$ :

$$ff_{t,0} = \frac{t}{D}r_0 + \frac{D-t}{D}\mathbb{E}_t(r_1) + \mu_{t,0}, \quad (1)$$

where  $\mu_{t,0}$  is a risk premium.<sup>4</sup> Gürkaynak et al. (2007) estimate risk premia of 1 to 3 basis points, and Piazzesi and Swanson (2008) show that they only vary at business-cycle frequencies. We focus on intraday changes to calculate monetary policy surprises and neglect risk premia in the following, as is common in the literature.

We can calculate the surprise component of the announced change in the federal funds rate,  $v_t$ , as:

$$v_t = \frac{D}{D-t}(ff_{t+\Delta t^+,0} - ff_{t-\Delta t^-,0}), \quad (2)$$

where  $t$  is the time when the FOMC issues an announcement,  $ff_{t+\Delta t^+,0}$  is the fed funds futures rate shortly after  $t$ ,  $ff_{t-\Delta t^-,0}$  is the fed funds futures rate just before  $t$ , and  $D$  is the number of days in the month.<sup>5</sup> The  $D/(D-t)$  term adjusts for the fact the federal funds futures settle on the average effective overnight federal funds rate.

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<sup>3</sup>We also exclude the rate cut on 9/17/2001 following the terrorist attacks because equity markets were closed for one week.

<sup>4</sup>We implicitly assume date  $t$  is after the previous FOMC meeting. Meetings are typically around six to eight weeks apart.

<sup>5</sup>We implicitly assume in these calculations that the average effective rate within the month is equal to the federal funds target rate and that only one rate change occurs within the month. Due to changes in the policy target on unscheduled meetings, we have six observations with more than one change in a given month. Because these policy moves were not anticipated, they most likely have no major impact on our results. We also exclude intermeeting policy decisions in the baseline analyses.

We follow Gürkaynak et al. (2005) and use the unscaled change in the next-month futures contract if the event day occurs within the last seven days of the month. This approach ensures small targeting errors in the federal funds rate by the trading desk at the New York Fed, revisions in expectations of future targeting errors, changes in bid-ask spreads, or other noise, which have only a small effect on the current-month average, are not amplified through multiplication by a large scaling factor.

Following the convention in the literature, we call monetary policy surprises expansionary when the new target rate is lower than predicted by fed funds futures before the FOMC meeting, that is, when  $v_t$  is negative and we call positive  $v_t$  contractionary. Table 1 reports descriptive statistics for surprises in monetary policy for all 154 event dates between 1994 and 2019 that we consider, as well as separately for turning points in monetary policy and intermeeting policy decisions. Turning points (target-rate changes in the direction opposite to previous changes) signal changes in the current and future stance of monetary policy and thus convey larger news (Piazzesi 2005, Coibion and Gorodnichenko 2012). Intermeetings are policy decisions that occur outside of scheduled FOMC meetings. The average monetary policy shock is approximately 0. The most negative shock is more than -45 basis points—about three times larger in absolute value than the most positive shock. Policy surprises on intermeeting event dates and turning points are more volatile than surprises on scheduled meetings. In columns (4) and (5), we report shocks separately for periods of high and low levels of VIX. High VIX FOMC decisions occur on policy meetings when the VIX 15 days before the meeting was above the trailing five year average VIX and accordingly for low VIX. The meetings are approximately evenly split across columns but we observe that shocks on high-VIX meetings are more volatile and slightly negative on average.

Table 2 reports the transition matrix for contractionary and expansionary shocks. We see contractionary shocks are about as likely to be followed by contractionary shocks as they are to be followed by expansionary shocks, and the same holds for expansionary shocks.

### III Empirical Results

#### A. Methodology

We follow a large event-study literature focusing on the conditional reaction of stock returns around contractionary and expansionary monetary policy shocks by the FOMC. Contrary to the recent literature studying intraday event windows of 30 to 60 minutes, we focus on drifts in returns several days up to a few weeks before and after the announcement. Specifically, the FOMC policy day constitutes event day 0, and we then study the reaction of returns in event time before and after the announcement, separating expansionary from contractionary monetary policy shocks.

#### B. Baseline

Figure 1 plots the return movements around FOMC announcements separately for expansionary and contractionary monetary policy surprises, which we calculate following equation (2). Expansionary monetary policy shocks are all surprises that are smaller than or equal to zero, whereas positive surprises are contractionary monetary policy shocks. In line with the recent literature, we focus on regular FOMC meetings and exclude FOMC policy decisions occurring on unscheduled meetings, so-called intermeeting policy decisions. Faust et al. (2004) argue that intermeeting policy decisions are likely to reflect new information about the state of the economy, and hence, the stock market might react to news about the economy rather than changes in monetary policy (see also Nakamura and Steinsson (2018)). In addition, intermeetings are not scheduled and we would not expect to find any pre-drift. We show robustness checks regarding the sample below.

We see in Figure 1 in the introduction stock returns start drifting upwards around 25 days before expansionary monetary policy decisions (blue-solid line), whereas stock returns are flat or drift down slightly before contractionary monetary policy decisions (red-dashed line). For both types of events, we see a positive return on the day before the FOMC meeting, the pre-FOMC announcement drift of Lucca and Moench (2015). On the day of the announcements, returns on average increase for expansionary surprises and the decrease for contractionary monetary policy shocks in line with Bernanke and Kuttner

(2005). For expansionary monetary policy events, stock returns continue to increase. Following contractionary shocks, instead, we see flat or slightly decreasing returns for the next 20 days. The difference in cumulative return drifts around contractionary and expansionary monetary policy surprises amounts to 4.5%.

The conduct of monetary policy has changed substantially during our sample period. To study whether our results differ pre- and post-ZLB period, we study subsample results in panel A and B of Figure 2. Across the two panels we find results that are consistent with our full sample analysis. Returns start increasing around 20 days before expansionary policy surprises and continue drifting upwards for several days. For higher than expected federal funds rates, we see flat or negative returns around the FOMC decisions.

The sensitivity of stock returns to monetary policy shocks varies across types of events. Ozdagli and Weber (2019) find larger sensitivities of stock returns to monetary policy shocks on turning points in monetary policy compared to regular meetings. Panel C of Figure 2 shows very similar drift patterns when we also exclude turning points in monetary policy in addition to intermeeting policy moves, both in sign and magnitude, and panel D of Figure 2 shows the same drift pattern in returns when we include both turning points and intermeeting policy moves.

So far, we assign meeting dates with zero monetary policy shock to the expansionary monetary policy shocks sample. Panel E of Figure 2 shows this definition does not drive our findings. When we exclude all events with zero policy surprises, we confirm our baseline findings.

Cieslak and Vissing-Jorgensen (2017) document a Fed Put; that is, the FOMC tends to lower federal funds target rates following weak stock returns. Panel F of Figure 2 plots cumulative returns for the CRSP value-weighted index when we split events by actual changes in federal funds target rates. We find stock returns tend to be lower before the FOMC lowers its target rate and higher before increases in target rates. Returns tend to remain flat when we condition on either positive or negative changes in the actual target rates. These results for actual changes in target rates are consistent with Cieslak and Vissing-Jorgensen (2017), but a Fed Put is unlikely to explain our findings, because we show that stock returns drift *upwards* before *lower-than-expected* federal funds target

rates, whereas returns tend to drift *downwards* before *cuts in actual* target rates.

So far, our analysis relies on graphs, eyeball econometrics, and cumulative returns from 50 days before until 50 days after the FOMC meeting. The choice of the window implies that in rare cases, part of the window might overlap with previous and subsequent FOMC meetings. Table 3 reports regression estimates for different event windows around FOMC policy decisions ranging from  $-15$  until  $+15$  days around the meetings ensuring no overlap across policy events occurs. Specifically, we regress cumulative returns of the CRSP value-weighted index from  $t^- = -15$  until  $t^- + s$ , with  $s$  running from 1 until  $+30$  and  $s = 15$  being the event day,  $r_{t^-, t^- + s}$ , on a constant and a dummy variable that equals 1 for expansionary monetary policy surprises,  $\mathcal{D}^{exp}$ :

$$r_{t^-, t^- + s} = \beta_0 + \beta_1 \times \mathcal{D}^{exp} + \varepsilon_{t^-, t^- + s}. \quad (3)$$

$\beta_0$  reports the average cumulative return around contractionary monetary policy surprises, whereas  $\beta_1$  reports the average differential cumulative return around expansionary monetary policy surprises relative to cumulative returns on contractionary policy meetings. We report robust t-statistics in parentheses.

Panel A of Table 3 reports results for our baseline sample excluding intermeeting policy releases. We see returns drift upwards before expansionary surprises relative to contractionary surprises. The drift is 1% 5 days before the FOMC meeting and marginally statistically significant and increases to 1.3% on the day before the policy meeting. Including the day of the release, the differential drift is 1.6% and statistically significant at the 5% level. Returns continue to drift upwards differentially, resulting in a difference in cumulative returns of 2% five days after the meeting and doubling to 3% 15 days after the meeting. All post-meeting estimates of  $\beta_1$  are significant at the 5% level or higher.

Despite the implications for shock identification which we allude to in the introduction and discuss in more detail below, a natural question may be if an investor could exploit the differential drift in real time? After all, investors do not know the sign of the shock 15 days before the shock occurs. We show in Section VI below that in fact the cumulative

returns before the announcement help predict the nature of the shock: contractionary versus expansionary. In Table 4 we now report the cumulative returns starting on the day following the FOMC policy decision. We see returns are higher after expansionary policy decisions compared to contractionary policy decisions immediately one day after the meeting but the difference is not statistically significant. The difference builds up over time and reaches almost 1.5% after 15 days and is significant at the 5% level.

### C. Cross-Sectional Factors

So far, we have focused on the drift of a broad market index around expansionary and contractionary monetary policy surprises, but the reaction of the CRSP value-weighted index might camouflage large cross-sectional heterogeneity. We first study the reaction of the four Fama and French (2015) factors in Figure 3.

Panel A of Figure 3 plots the drift around FOMC announcements for the size factor. Cumulative excess returns are close to zero around both expansionary and contractionary monetary policy surprises. The non-response of the size factor might reflect the insignificant unconditional size premium during our sample period.<sup>6</sup>

Panel B of Figure 3 plots the drift for the value factor, panel C plots the drift for the profitability factor, and panel D of Figure 3 plots the drift for the investment factor. Overall, little drift occurs either before or after the announcement for all four factors for expansionary monetary policy surprises. Before contractionary monetary policy surprises, we see an upward drift of value firms relative to growth firms, high-profitability relative to low-profitability firms, and low- relative to high-investment firms, but the drift levels off at the announcement and is smaller than the drift for the overall market.

Lastly, panel A of Figure 4 plots the drift for beta-sorted portfolios. The dashed lines report the drift for portfolio 10 consisting of the decile of firms with the highest beta and the solid lines refer to the drift for low-beta stocks. We see differential drift for high-beta stocks relative to low-beta stocks both before the policy announcement but also

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<sup>6</sup>Asness, Frazzini, Israel, Moskowitz, and Pedersen (2018) show that firm size is highly correlated with other firm characteristics, and once they condition on these, the size effect reappears. This result is consistent with evidence in Freyberger, Neuhierl, and Weber (2020) and Chincó et al. (2020), who find that the size effect conditional on other firm characteristics is strongest in the modern sample period.

after the policy announcement. High-beta stocks have both a higher upwards drift than low-beta stocks before expansionary FOMC announcement but also a higher downward drift around contractionary monetary policy decisions. Contrary to conventional wisdom (Fama and French (1992) and Frazzini and Pedersen (2014)), CAPM betas successfully predict the stock market response around monetary policy decisions consistent with Savor and Wilson (2013, 2014), Weber (2015), and Andrei et al. (2018).

Bernanke and Kuttner (2005), Lucca and Moench (2015), and Ozdagli and Weber (2019) attribute a large part of equity returns to monetary policy. Andrei et al. (2018) argue the reason the CAPM holds on FOMC announcement days because it reduces the information gap between the econometrician and the average investor holding the market. To understand whether the CAPM helps explain the differential drift for high- versus low-beta portfolios because monetary policy announcements contain important news, we propose a placebo test. Specifically, panel B Figure 4 plots the drift for beta-sorted portfolios around FOMC meetings during the ZLB period. By construction, the FOMC released no relevant information about actual target rate changes on these meetings. Nevertheless, the federal funds futures still vary and allow us to construct shocks following the methodology of Section II. We see no differential drift around FOMC meetings for high- versus low-beta stocks. This non-result suggests that the CAPM holds on FOMC days because monetary policy decisions about target rates contain relevant information for equity markets. This test does not assume that the FOMC does not implement unconventional monetary policy tools during the binding ZLB period or that forward guidance about future rate changes does not occur (Neuhierl and Weber (2019)). Instead, we only require the FOMC to not release new information about current target rate changes that closes the information gap (Andrei et al. (2018)).

#### **D. Industry Returns**

Industries might react differentially to monetary policy shocks, because of demand effects, different sensitivities to monetary policy, or different degrees of price stickiness (Weber (2015), D’Acunto et al. (2018), and Bhamra et al. (2018)). Durable-goods demand is particularly volatile over the business cycle, and consumers can easily shift the timing

of their purchases, thus making monetary policy sensitivity especially high (see, e.g., D’Acunto, Hoang, and Weber (2017) and D’Acunto et al. (2019)).

Figure 5 plots the cumulative industry returns following the Fama & French 17-industry classification for expansionary monetary policy shocks in blue and for contractionary monetary policy shocks in red. For all but one industry, we see a differential drift around expansionary versus contractionary monetary policy surprises that averages to around 4%, consistent with the overall results for the CRSP value-weighted index. The mining industry is an exception, because returns also drift upwards around contractionary monetary policy shocks (see bottom left panel of Figure 5). We observe the largest differential drift for the machinery industry, with a cumulative return difference of more than 8% (see top right panel of Figure 5).

## **E. International Equity Returns**

We now study international equity returns around FOMC meetings to see whether similar return patterns are present around the world. Lucca and Moench (2015) already document that their pre-FOMC announcement drift is a global phenomenon in that international stock indices appreciate in the 24 hours before the announcement of U.S. monetary policy decisions.<sup>7</sup>

Figure 6 plots the cumulative return drifts of the German DAX 30 index around expansionary and contractionary monetary policy decisions in panel A, the Canadian TSX in panel B, the French CAC40 in panel C, the Spanish IBEX in panel D, the Swiss SMI in panel E and the British FTSE in panel F. Similar to the evidence for the United States, we see stock returns drifting differentially before expansionary versus contractionary surprises starting around 20 days before the U.S. monetary policy decision. The return gap between the two types of events increases to around 3% to 4% on the day of the FOMC meeting. Returns of these indices, however, continue to drift in the same direction, so that the return gap widens to 4% to 6% 15 days after the FOMC meeting.

We find in unreported results that the Japanese Nikkei 225 is an exception with

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<sup>7</sup>The results are also consistent with Brusa et al. (2018), who document a global FOMC announcement drift around the world that is unique to announcements of the FOMC compared monetary policy decisions of other central banks around the globe.

almost zero return drift around FOMC decisions independent of whether they are expansionary or contractionary. The non-result for the Nikkei is consistent with Lucca and Moench (2015), who also do not find any pre-FOMC return drift for Japan.

## IV Trading Strategy and Spanning Tests

We now study the economic magnitude of possibly implementable trading strategies and compare them to popular alternative factors and a buy-and-hold investment. Furthermore, we study in spanning tests whether monetary momentum is spanned by standard asset pricing factors.

### A. Trading Strategy

We report daily mean returns, standard deviations, and annualized Sharpe ratios in Table 5, to benchmark the economic significance of the differential drift of the CRSP value-weighted index around FOMC monetary policy decisions across expansionary and contractionary policy surprises. Specifically, we compare the Sharpe ratios of monetary momentum strategies to the ones for a passive buy-and-hold strategy for event windows around the FOMC meeting  $t$  of different lengths in trading days. Investors cannot necessarily implement the trading strategies in columns (2) and (4) but the strategies in columns (6) and (8) are implementable in real time. The event window in columns (1) and (2) starts 15 days before the FOMC meeting and ends 15 days after the FOMC meeting. The monetary momentum strategy invests in the market when the monetary policy shock is expansionary, and shorts the market when the monetary policy shock is contractionary. We calculate the annualized Sharpe ratio as the ratio of the daily mean excess return and the daily standard deviation multiplied by the square root of 252.

We see in column (1) of panel A1 that holding the market in the 30 days around the FOMC meeting results in an annualized Sharpe ratio of 0.26. The baseline monetary momentum strategy, instead, has a Sharpe ratio of 0.68, which is more than 2.5 times larger than the Sharpe ratio of the passive long-only strategy.

Lucca and Moench (2015) document large returns in the 24 hours before the FOMC

meeting. These large returns cannot explain the increase in Sharpe ratios by a factor of 2.5, because the buy-and-hold strategy automatically harvests these returns. In columns (3) and (4), we nevertheless study event windows that exclude the day of and the day before the FOMC meeting.<sup>8</sup> We see that a passive buy-and-hold strategy earns a small Sharpe ratio of only 0.08 when we exclude the large returns before the FOMC meeting. The monetary momentum strategy instead still earns an economically meaningful Sharpe ratio of 0.53.

So far, we might not be able to implement the monetary momentum strategies we study, because we do not know the sign of the monetary policy surprise 15 days before the FOMC meeting. We now study event windows that start only the day after the FOMC meeting in columns (5) and (6). The passive buy-and-hold strategy has a Sharpe ratio of 0.18 only. A strategy that starts investing in the market for 15 days whenever the monetary policy surprise was negative on the previous day instead earns an annualized Sharpe ratio of 0.57, which is larger by a factor of 3.

Columns (7) and (8) compare the Sharpe ratio of a strategy that holds the market throughout the year with a *buy-and-hold strategy plus* that shorts the market for 15 days following any contractionary monetary policy surprise. We see that this simple timing strategy that is implementable in real time increases annualized Sharpe ratios by more than 50%. Panels A2 and A3 show qualitatively similar results for the periods before and after the ZLB. Despite the fact that the overall market return was relatively large in the post Great Recession period, we still see that conditioning on the sign of the monetary policy surprise helps boost performance.

For comparison, Panel B lists annualized Sharpe ratios for the four Fama & French factors and the time-series momentum strategy of Moskowitz et al. (2012). The simple *monetary momentum* market-timing rule generate Sharpe ratios that are comparable to the Sharpe ratios of leading risk factors and do not require frequent rebalancing or the trading of a large number of possibly illiquid stocks. Most notably, monetary momentum still delivers large Sharpe ratios also in the period starting in 2015 when most cross sectional return factors have low or even negative Sharpe ratios (compare panels A3 and

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<sup>8</sup>We work with daily returns, and both days cover part of that pre-FOMC drift window.

B3).

## **B. Spanning Tests, Monetary Momentum and Time-Series Momentum**

In an influential paper, Moskowitz, Ooi, and Pedersen (2012) show large time-series momentum across asset classes such as equity indices, currencies, commodities, and bond futures. They show the past 12-month returns of each instrument positively predicts future returns. Time-series momentum returns might partially explain the return drifts we document around FOMC meetings.

To study the associations between time-series momentum and monetary momentum, we adapt the Moskowitz, Ooi, and Pedersen (2012) time-series strategy to our context and start investing in the market index 15 days before the FOMC meeting whenever the return of the market excess return was positive over the previous 12 months, and short the market whenever the excess return was negative. Table 6 reports results from different spanning tests to see whether monetary momentum is economically different from time-series momentum and other well-known trading strategies. The return series are for 30 days symmetric window around scheduled FOMC decisions starting 15 days before the meeting.

We see in column (1) that monetary momentum and time-series momentum strategies are negatively correlated. But even after controlling for exposure to time-series momentum, we still find a positive, statistically significant alpha of 0.048% per day, which is about 12% annualized. Column (2), instead, shows that monetary momentum does not subsume time-series momentum. Columns (3) and (4) regress monetary momentum strategies on time-series momentum and the Fama & French factors. Column (4) implies monetary momentum expands the mean-variance frontier relative to the Fama & French 4 factors and time-series momentum and results in annualized excess returns of 8%.

## **V Economic Mechanism**

Laarits (2019) distinguishes between Fed information effects and conventional monetary

policy news and develops a model in which the pre-FOMC announcement drift occurs because of resolution of uncertainty about announcement type. Hu et al. (2019) extend the pre-FOMC announcement drift to other macroeconomic announcements and develop a theory arguing “heightened uncertainty” in anticipation of a pre-scheduled announcement drive the drift consistent with results in Neuhierl and Weber (2019) who document the pre-FOMC announcement drift of Lucca and Moench (2015) is only present during periods of high uncertainty.

To study whether the level of uncertainty is also relevant for our extended differential pre- and post-announcement drift across expansionary and contractionary monetary policy surprises, we proceed as follows. We compare the level of the VIX 15 days before the FOMC meeting to the rolling historical mean level of the VIX over the recent five years. If the pre-meeting VIX is above the historical average, we label the meeting a VIX high meeting. If it is instead below the historical mean, we label it a VIX low meeting.

Figure 7 reports the results. We see in panel A a large differential pre- and post FOMC announcement drift across expansionary and contractionary policy meetings during periods of high uncertainty. Until 25 days before the FOMC meeting, cumulative returns of the CRSP value-weighted index for positive and negative monetary policy surprises follow parallel trends. Around day 25, the cumulative returns start diverging resulting in a differential cumulative return on the day before the FOMC meeting of about 4%. The difference in cumulative returns increases post event to almost 8% 15 days after the FOMC meeting.

Panel B instead plots the cumulative returns around FOMC meetings for expansionary policy decisions in solid blue and contractionary meetings in dashed red when the VIX is below the historical mean. During calm markets when the VIX is below historical levels, we see both lines follow parallel trends before the meeting, both experience a small FOMC announcement drift before the actual FOMC meeting and post meeting, only a small gap opens up across the two meeting types.

Table 3 reports the return numbers that come with the Figure. We see in panel B that the cumulative return drift from 15 days before to 15 days after the FOMC meeting for expansionary policy decisions increases from the baseline return of 3% by more than

50% to 4.65% during periods of high uncertainty. When the VIX 15 days before the meeting is instead below the rolling historical mean, we only find a modest return drift that is not statistically significant.

Taken together, the evidence in Figure 7 and Table 3 suggests the level of uncertainty and market turmoil as proxied for by the VIX is not only important for the pre-FOMC announcement drift of Lucca and Moench (2015) as hypothesized by Laarits (2019) and Hu et al. (2019) and empirically confirmed in Neuhierl and Weber (2019), but it also modulates the monetary momentum effect that we uncover and document in the current paper. The FOMC might surprisingly cut rates in times of high risk or risk aversion, which could possibly explain the upward drift around events we associate with expansionary shocks. Consistent with this idea, Table 1 shows monetary policy shocks are on average more expansionary in periods of high uncertainty as proxied for by the VIX.

Alternatively, it might be possible Fed officials informally communicate (“leak”) with financial market participants or reporters (Cieslak et al. (2019) and Vissing-Jorgensen (2020)). This informal communication would have to signal the subsequent sign of the monetary policy shock that possibly differs from the sign actual change in policy rates with the latter resulting in the opposite return patterns (compare Figure 1 with Panel F of Figure 2). Moreover, these leaks would have to be more frequent, more explicit, or interpreted differently by market participants in times of high levels of VIX. Additionally, we would still need to explain the unconditional pre-FOMC announcement drift in the 24 hours before the actual FOMC meeting occurs, and then a continuation in returns post announcement, possibly due to underreaction to news.<sup>9</sup>

## VI Predictability of Monetary Policy Shocks

We find returns start drifting upwards several days before expansionary monetary policy decisions. We now want to study whether the cumulative returns before FOMC meetings can actually predict monetary policy *shocks*.

A large literature in macroeconomics and monetary economics tries to understand

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<sup>9</sup>We thank Stefan Nagel for inspiring this alternative interpretation.

the real effects of *exogenous* monetary policy *shocks* on real consumption, investment, and GDP. Traditionally, this literature uses low frequency data and various identification schemes such as recursiveness or sign restrictions in VARs (see Christiano et al. (1999) and Uhlig (2005)) and narrative identification (Romer and Romer (2004)). Yet, real macro aggregates only respond to monetary policy with “long and variable lag” (Friedman (1961)) which is why a recent literature uses the stock market as a proxy for the real effects and zooms into narrow event windows to gain identification. Bernanke and Kuttner (2005) is an excellent example for this latter approach. Yet, this high-frequency event study literature relies on the shocks being exogenous and not predictable.

We now study whether the cumulative return in the 15 trading days before the scheduled FOMC meeting helps predict the actual policy surprise. In case it did, we would have to conclude that Kuttner (2001) shocks are in fact no shocks but are predictable with important implications for the monetary event study literature. Figure 8 first graphically studies the association between cumulative pre-event returns and actual event policy surprises in binned scatter plots that facilitate graphically interpretation. We see in panel A a negative association between cumulative pre-event returns and FOMC shocks exists. Positive returns over the 15 days before the FOMC meeting predict expansionary monetary policy shocks, that is, fed funds rates post event that are lower than futures-market expectations and vice versa for negative pre-event returns.

Panels B and C split the sample of FOMC events again into those that occur in periods of high uncertainty (VIX high) and low uncertainty (VIX low). We want to stress that we determine whether events belong to either category based on data that is available 15 days before the event: the level of VIX on that day and the historical moving average of the VIX. We see in panel B a strong negative association between past 15-days returns and subsequent monetary policy shocks, whereas the association is more mute during periods of low VIX in panel C.

We formally test for predictability in Table 7. We see in column (1) the negative association between past returns and monetary policy shocks that is statistically significant at the 5% level. Economically, a cumulative pre-event return of 8% which corresponds roughly to a two-standard deviation move predicts a negative surprise of 2 bps

that corresponds to 26% of a standard deviation which is economically sizable. Columns (2) and (3) again decompose the FOMC events into those occurring during high- and low-VIX periods. We find a strong predictability of monetary policy shocks by previous cumulative stock returns during months of high uncertainty. During low VIX months, instead, we don't detect any predictability. Economically, a cumulative pre-event return of 9.5% which corresponds roughly to a two-standard deviation move for high-VIX events predicts a negative surprise of 2.8 bps that corresponds to more than half a standard deviation of the shocks during these periods.

This predictability does not seem to occur due to any autocorrelation in shocks. When we regress current shocks on a constant and shocks from the last meeting, we find a point estimate on the lagged shock of -0.09 with a p-value of 28%, making it unlikely that the predictability of monetary policy shocks by past market returns originates due to any persistence in the shocks themselves.

Transition matrices are another way to study possible persistence in monetary policy shocks. Table 2 shows contractionary shocks are followed 45 times by other contractionary shocks but also 38 times by expansionary shocks. On the other hand, contractionary shocks follow expansionary shocks 38 times, but other expansionary shocks follow 32 times. Hence, little persistence exists in the type of shocks, which makes it unlikely that the sign of the shocks is predictable by past shocks.

Our findings on the predictability of monetary policy shocks are consistent with the interpretation of the “Fed information effect” by Bauer and Swanson (2020). Campbell et al. (2012) and Nakamura and Steinsson (2018) document that surprise cuts in monetary policy rates sometimes predict weaker rather than stronger private sector forecasts of GDP and higher rather lower unemployment forecasts. The conventional interpretation of these patterns is the FOMC action signals to the markets and public that the economy is in fact weaker than previously expected resulting in surprise interest rate cuts and the downward revision of economic forecasts. Bauer and Swanson (2020) instead advance the possibility that both the FOMC and the private sector forecasters might jointly update their forecasts due to incoming, publicly available news. We add to their interpretation in that the stock market drift before the FOMC meetings we uncover might capture the publicly available

news.<sup>10</sup>

Independent of the origin, the predictability of fed funds futures based monetary policy shocks by past cumulative stock returns implies these shocks are not exogenous and researchers in macroeconomics should possibly regress these shocks on past returns to orthogonalize the shocks. The predictability might also explain some puzzling findings in the literature such as the “price puzzle”, that is, the fact that consumer prices increase in the short run following contractionary monetary policy shocks.

## VII Concluding Remarks

Momentum is a pervasive feature across asset classes, countries, and sample periods. We document novel time-series momentum strategies around monetary policy decisions in the United States. Starting 25 days before expansionary monetary policy announcements, stock returns start drifting upwards. Before contractionary monetary policy surprises returns drift downwards. The differential drift continues after the policy decision for another 15 days and amounts to 4% per year within 30 days of the monetary policy decision.

The differential drift we document is largely a market-wide phenomenon and holds for all industries, but we find little differential drift for cross-sectional asset-pricing factors. Beta-sorted portfolios are an exception: high-beta stocks are more sensitive to the differential market-wide drift around FOMC meetings across expansionary and contractionary meetings. The drift we document is a global phenomenon, and major stock indices around the world exhibit the differential drift around U.S. contractionary and expansionary monetary policy decisions.

A simple market-timing strategy that exploits the monetary momentum strategy we document improves on the Sharpe ratio of a buy-and-hold investor by a factor of 4, and investors can implement the strategy in real time.

We document that the cumulative return differential is especially large in periods of high uncertainty as proxied by VIX consistent with recent theories such as Laarits (2019)

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<sup>10</sup>We thank Carolin Pflueger for proposing this mechanism.

and Hu et al. (2019).

Our findings have important implications for policy and research. First, a recent literature studies the effect of monetary policy on asset prices using narrow event windows of 30 or 60 minutes around FOMC policy decisions to obtain identification. The large drift before and after FOMC decisions suggests researchers might underestimate the effect of monetary policy on asset prices by restricting attention to narrow event windows. Second, the magnitude of the drift around FOMC decisions suggests asset-pricing theories that aim to understand the unconditionally large excess returns of stocks relative to bonds should focus on channels through which monetary policy and asset markets interact. Third, the pre-drift around FOMC decisions implies “surprise changes” in target rates might partially be predictable, which has important implications for the large literature in macroeconomics and monetary economics that tries to understand the real effects of monetary policy shocks on real consumption, investment, and GDP and warrants future research.

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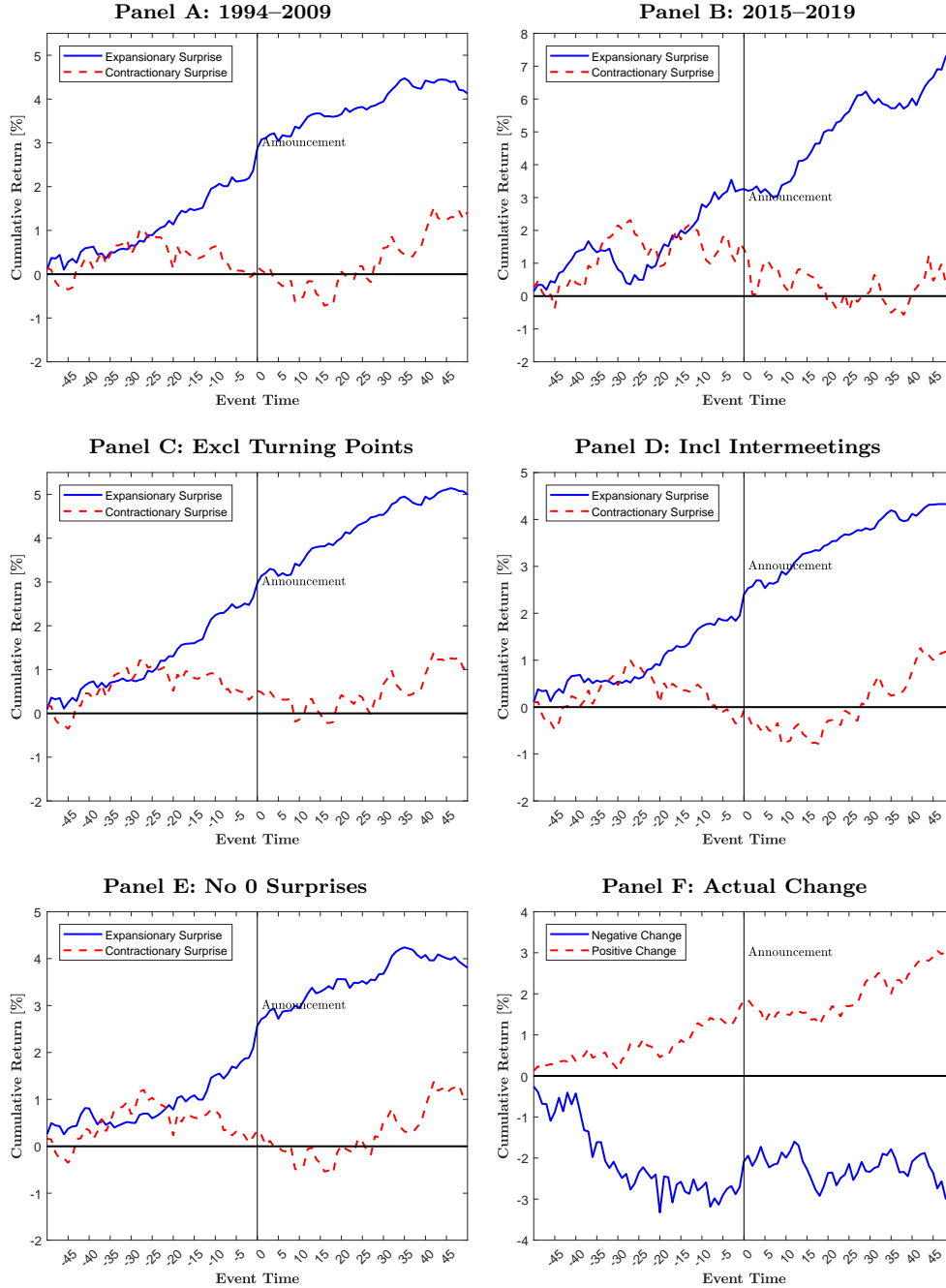
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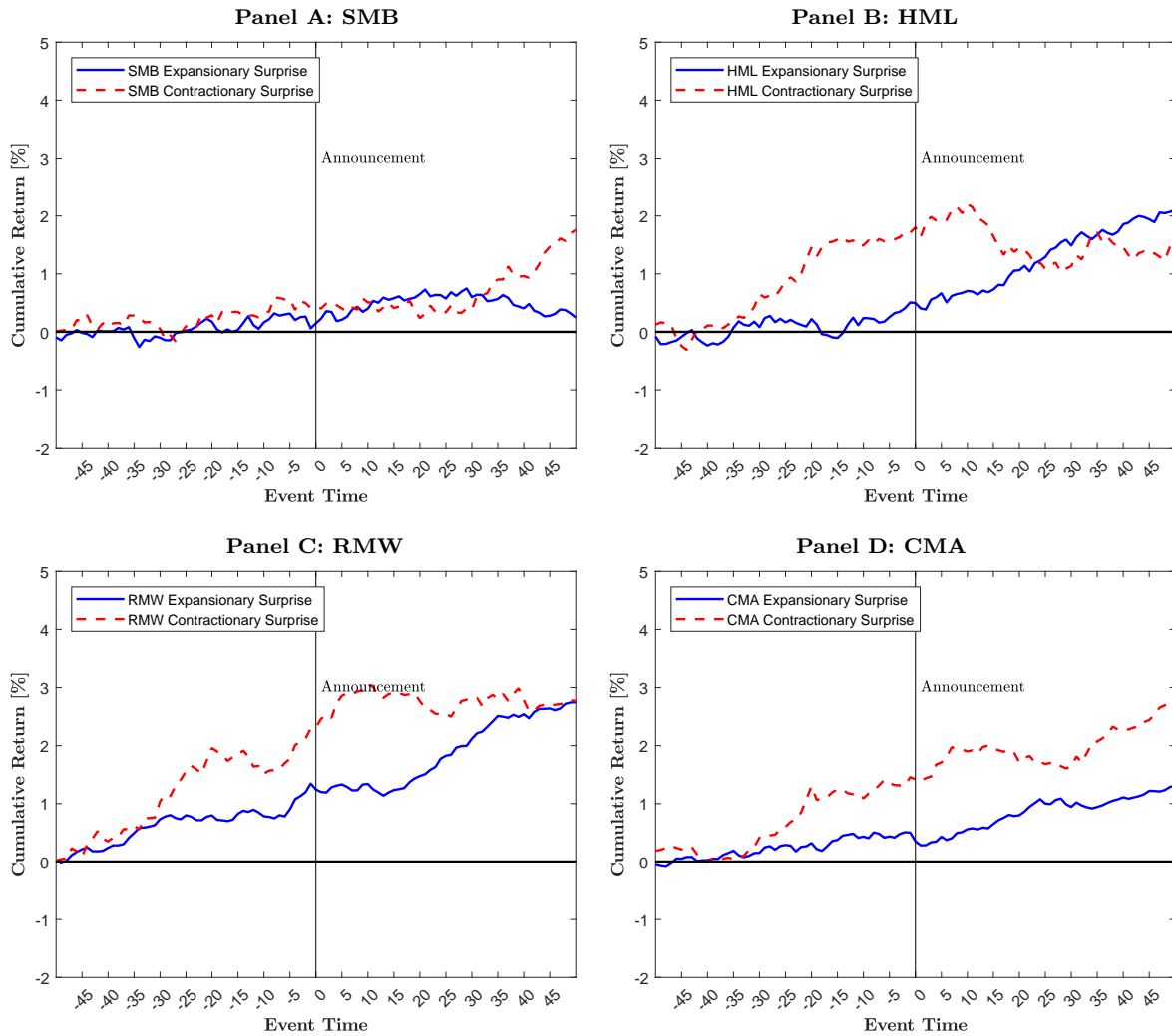
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Figure 2: Cumulative Returns around FOMC Policy Decisions: Robustness



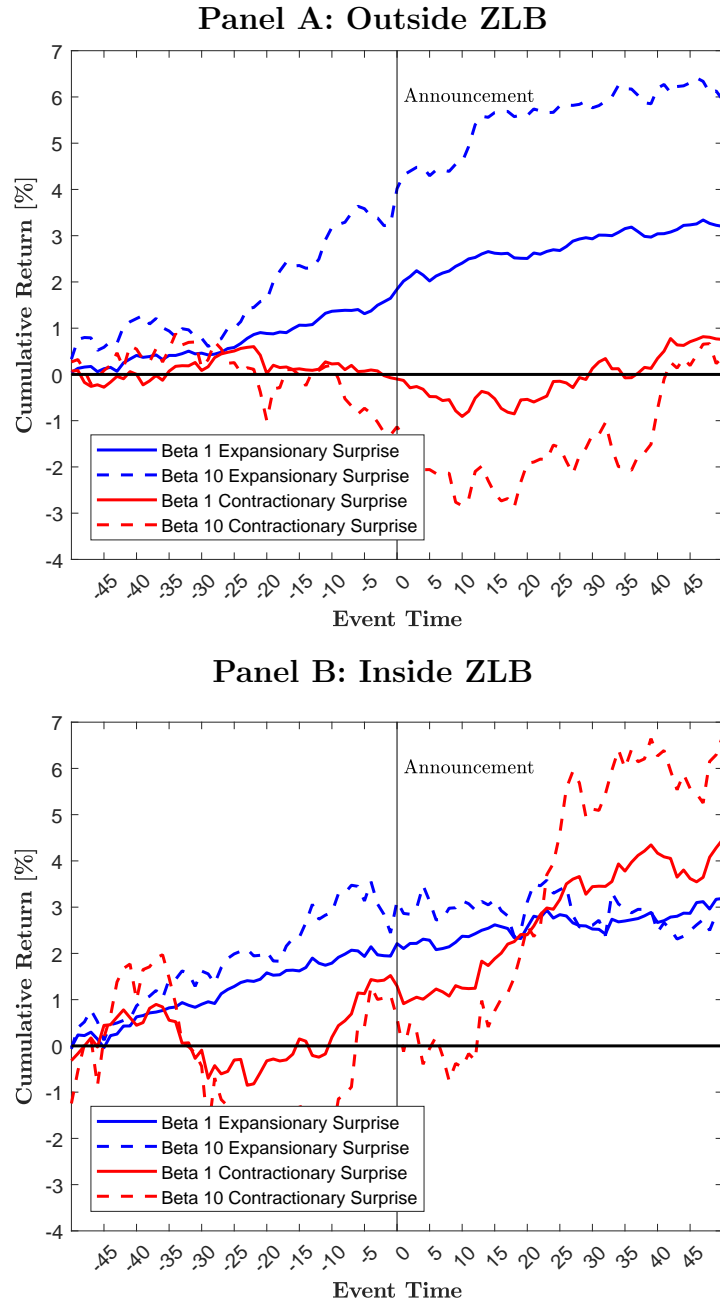
*This figure plots cumulative returns in percent around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.*

Figure 3: Cumulative Returns around FOMC Policy Decisions: Factors



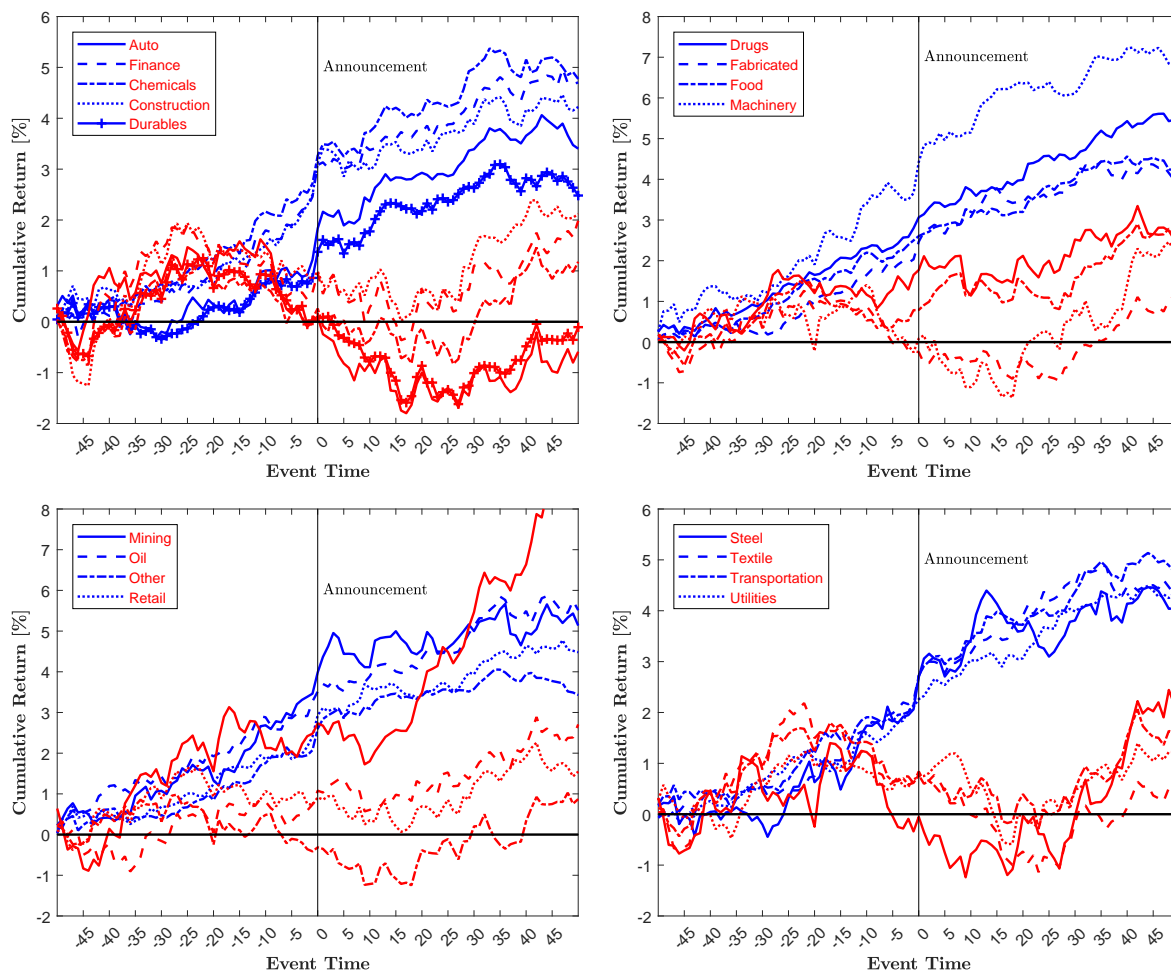
*This figure plots cumulative returns in percent for the SMB, HML, RMW and CMA factor around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.*

Figure 4: Cumulative Returns around FOMC Policy Decisions: Beta



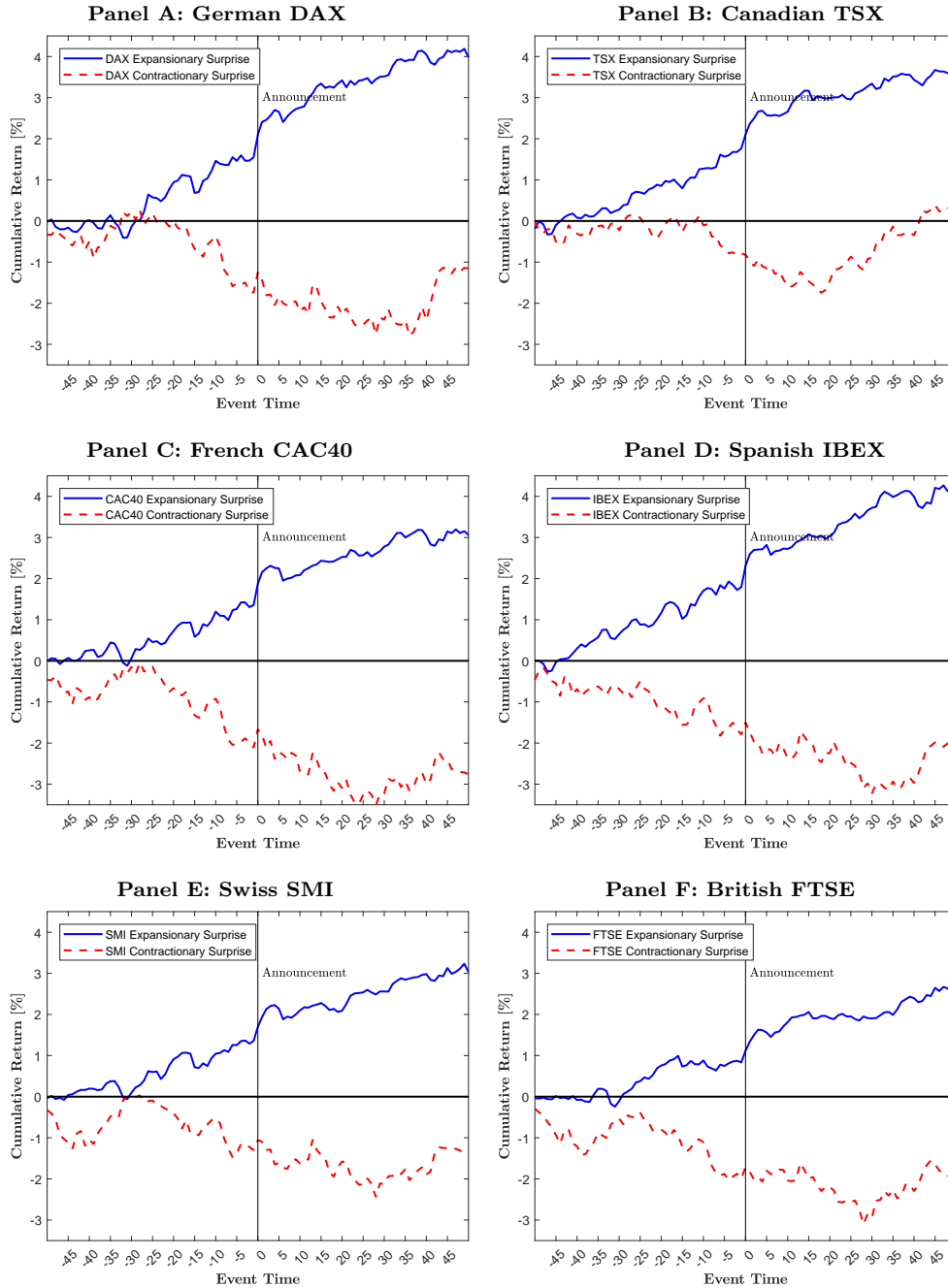
*This figure plots cumulative returns in percent for CAPM beta sorted portfolios around FOMC policy decisions separately for positive (contractionary; red lines) and negative (expansionary; blue lines) monetary policy surprises. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.*

Figure 5: Cumulative Returns around FOMC Policy Decisions: Industry Returns



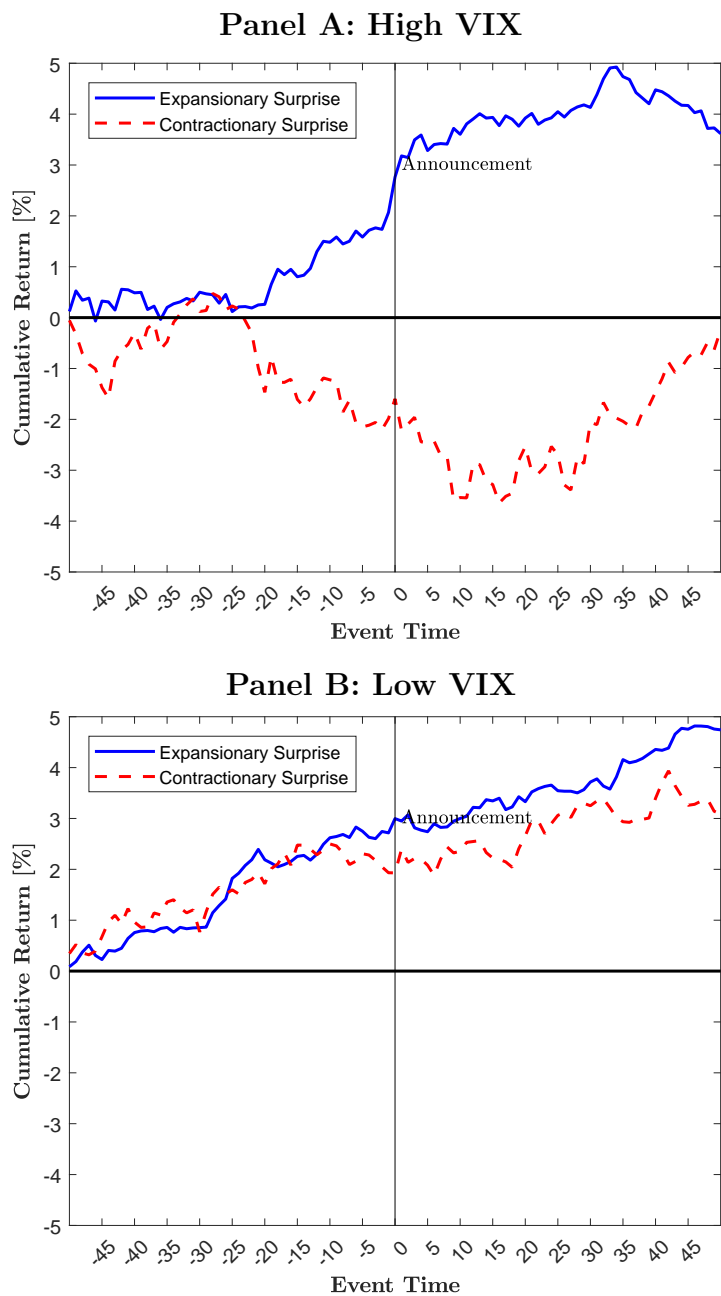
*This figure plots cumulative returns in percent at the industry level around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.*

Figure 6: **Cumulative Returns around FOMC Policy Decisions: International**



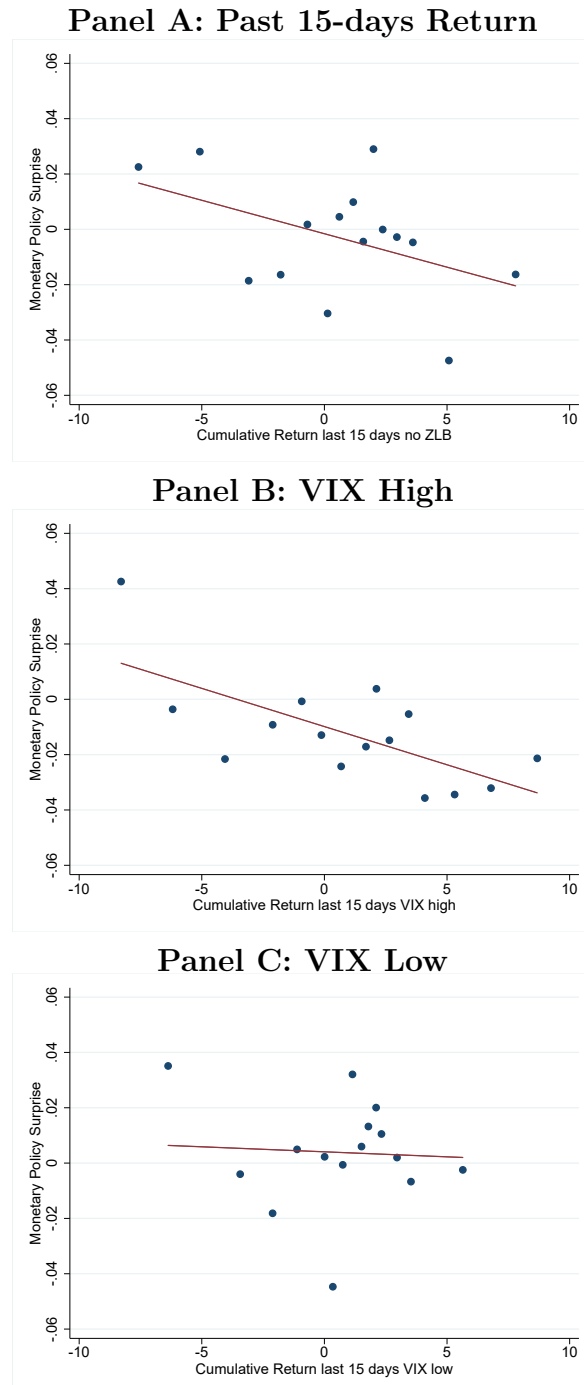
*This figure plots cumulative returns in percent for the DAX 30 around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015.*

Figure 7: Cumulative Returns around FOMC Policy Decisions: VIX



*This figure plots cumulative returns in percent around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. We condition on the VIX 15 days pre-FOMC event being above the average VIX over the trailing five-year period. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.*

Figure 8: Bin Scatter Plot of Previous Returns and Monetary Policy Surprises



*This figure plots cumulative excess returns in percent in the 15 days before the FOMC meeting and the federal-funds-futures-based monetary policy shocks in the top and middle panels and the previous-day returns in the bottom panels. VIX high (low) includes meetings for which the VIX 15 days before the meeting was above (below) the rolling five-year average value. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.*

Table 1: Monetary Policy Shocks

*This table reports descriptive statistics for monetary policy shocks separately for all 137 event days between 1994 and 2019 excluding the months from January 2010 until November 2015, turning points in monetary policy, and intermeeting policy decisions. The policy shock is calculated according to equation (1) as the scaled change in the current-month federal funds futures in a 30-minute window bracketing the FOMC press releases.*

	All Event Days (1)	Turning Points (2)	Intermeeting Releases (3)	VIX High (4)	VIX Low (5)
Mean	-1.31	-9.29	-16.12	-3.28	0.51
Median	0.00	-3.00	-12.95	-0.55	0.00
Standard deviation	8.38	15.90	22.84	10.47	5.26
Min	-46.67	-39.30	-46.67	-46.67	-22.60
Max	16.30	5.00	8.68	10.00	16.30
Observations	154	7	7	74	80

Table 2: **Shock Transition Matrix**

*The table reports the transition matrix of shocks from contractionary to expansionary. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015.*

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	Contractionary	Expansionary
Contractionary	45	38
Expansionary	38	32

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Table 3: Cumulative Returns around FOMC Decisions (conditional on VIX)

Panel A reports the cumulative return of the CRSP value-weighted index around FOMC policy decisions, excluding policy decisions on intermeetings.  $\mathcal{D}^{exp}$  is a dummy that equals 1 if the monetary policy surprise is negative (expansionary). 0 is the day of the FOMC meeting. Panel B conditions on meetings for which the VIX 15 days before the meeting was above the rolling five-year average value, and Panel C conditions on meetings for which the VIX 15 days before the meeting was above the rolling five-year average value. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015.

	-15	-10	-5	-1	0	1	2	3	4	5	10	15
<b>Panel A. Baseline</b>												
$\mathcal{D}^{exp}$	0.05 (0.22)	0.37 (0.77)	0.99* (1.67)	1.30* (1.83)	1.62** (2.26)	1.87** (2.43)	2.12*** (2.70)	2.10** (2.59)	2.21*** (2.73)	2.09** (2.59)	2.79*** (3.04)	3.06*** (2.85)
Constant	-0.03 (-0.14)	0.20 (0.48)	-0.26 (-0.53)	-0.34 (-0.54)	-0.22 (-0.36)	-0.33 (-0.48)	-0.54 (-0.77)	-0.44 (-0.61)	-0.56 (-0.80)	-0.57 (-0.84)	-1.03 (-1.31)	-0.89 (-0.95)
Nobs	157											
Adjusted $R^2$	-0.01	0.00	0.01	0.02	0.03	0.04	0.05	0.04	0.05	0.04	0.05	0.05
<b>Panel B. VIX High</b>												
$\mathcal{D}^{exp}$	0.28 (0.64)	0.48 (0.54)	1.38 (1.31)	1.72 (1.32)	2.17 (1.66)	3.16** (2.17)	3.23** (2.22)	3.58** (2.41)	3.89** (2.64)	3.54** (2.49)	4.87*** (2.94)	4.65** (2.53)
Constant	-0.39 (-1.00)	0.04 (0.06)	-0.84 (-0.97)	-0.67 (-0.57)	-0.44 (-0.38)	-1.09 (-0.82)	-1.16 (-0.88)	-1.11 (-0.83)	-1.40 (-1.07)	-1.35 (-1.11)	-2.37 (-1.65)	-1.78 (-1.09)
Nobs	76											
Adjusted $R^2$	-0.01	-0.01	0.01	0.02	0.03	0.06	0.07	0.08	0.09	0.07	0.10	0.08
<b>Panel C. VIX Low</b>												
$\mathcal{D}^{exp}$	-0.14 (-0.85)	0.28 (0.61)	0.66 (1.10)	0.92 (1.35)	1.10 (1.60)	0.69 (1.09)	1.09 (1.54)	0.72 (0.96)	0.65 (0.87)	0.74 (0.91)	0.88 (1.04)	1.60 (1.35)
Constant	0.29* (1.98)	0.34 (0.81)	0.25 (0.46)	-0.05 (-0.08)	-0.03 (-0.05)	0.35 (0.63)	0.01 (0.02)	0.16 (0.25)	0.18 (0.29)	0.12 (0.17)	0.17 (0.24)	-0.11 (-0.10)
Nobs	81											
Adjusted $R^2$	0.00	-0.01	0.01	0.02	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.01

t-statistics in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 4: **Cumulative Returns after FOMC Decisions: Post Announcement**

The table reports the cumulative return of the CRSP value-weighted index following FOMC policy decisions, excluding policy decisions on intermeetings.  $\mathcal{D}^{exp}$  is a dummy that equals 1 if the monetary policy surprise is negative (expansionary). 0 is the day of the FOMC meeting. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015

	1	2	3	4	5	10	15
$\mathcal{D}^{exp}$	0.27 (1.27)	0.51* (1.76)	0.50 (1.44)	0.59 (1.58)	0.45 (1.08)	1.16** (2.36)	1.44** (2.26)
Constant	-0.11 (-0.65)	-0.32 (-1.34)	-0.22 (-0.79)	-0.34 (-1.10)	-0.33 (-0.98)	-0.82** (-2.02)	-0.70 (-1.33)
Nobs				157			
Adjusted $R^2$	0.00	0.01	0.01	0.01	0.00	0.03	0.03

t-statistics in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 5: Trading Strategies and Sharpe Ratios

The table reports daily mean excess returns, standard deviations, and annualized Sharpe ratios of buy-and-hold strategies and monetary momentum strategies for different event windows in trading days around FOMC policy decisions, excluding policy decisions on intermeetings, in Panel A, and for the five Fama & French factors plus times-series momentum and cross-sectional momentum in Panel B.  $t$  indicates the FOMC meeting. The monetary momentum strategy is invested in the market when the monetary policy shock is expansionary and shorts the market for contractionary monetary policy surprises. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015.

Panel A. Market and Monetary Momentum								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$t-15 - t+15$		$t-15 - t+15$ , excl $t-1$ & $t=0$		$t+1 - t+15$		Annual	
	Buy and hold	Monetary Momentum	Buy and hold	Monetary Momentum	Buy and hold	Monetary Momentum	Buy and hold	Buy and hold +
Panel A1. 1994–2019								
Mean	0.02%	0.05%	0.01%	0.04%	0.01%	0.05%	0.03%	0.04%
Std	(1.25%)	(1.25%)	(1.24%)	(1.24%)	(1.26%)	(1.25%)	(1.19%)	(1.18%)
SR <sub>annualized</sub>	0.26	0.68	0.08	0.53	0.18	0.57	0.38	0.59
Panel A2. 1994–2009								
Mean	0.02%	0.05%	0.00%	0.04%	0.01%	0.04%	0.02%	0.04%
Std	(1.31%)	(1.31%)	(1.30%)	(1.30%)	(1.31%)	(1.30%)	(1.24%)	(1.24%)
SR <sub>annualized</sub>	0.19	0.61	-0.02	0.43	0.12	0.51	0.31	0.52
Panel A3. 2015–2019								
Mean	0.04%	0.07%	0.04%	0.07%	0.03%	0.06%	0.05%	0.06%
Std	(0.86%)	(0.86%)	(0.87%)	(0.87%)	(0.96%)	(0.96%)	(0.85%)	(0.85%)
SR <sub>annualized</sub>	0.80	1.38	0.75	1.36	0.57	0.99	0.88	1.11
Panel B. Factors								
	TS Mom	SMB	HML	Prof	Invest	Mom		
Panel B1. 1994–2019								
Mean	0.03%	0.01%	0.01%	0.02%	0.01%	0.02%		
Std	(1.25%)	(0.62%)	(0.70%)	(0.53%)	(0.49%)	(1.00%)		
SR <sub>annualized</sub>	0.44	0.18	0.24	0.62	0.30	0.29		
Panel B2. 1994–2009								
Mean	0.04%	0.01%	0.01%	0.02%	0.01%	0.02%		
Std	(1.31%)	(0.64%)	(0.72%)	(0.55%)	(0.51%)	(1.04%)		
SR <sub>annualized</sub>	0.48	0.23	0.32	0.62	0.39	0.35		
Panel B3. 2015–2019								
Mean	0.01%	-0.01%	-0.01%	0.02%	-0.01%	0.00%		
Std	(0.86%)	(0.51%)	(0.55%)	(0.35%)	(0.36%)	(0.74%)		
SR <sub>annualized</sub>	0.19	-0.18	-0.30	0.68	-0.32	-0.01		

Table 6: **Spanning Tests**

*The table reports spanning tests of monetary momentum and times-series momentum strategies on the Fama & French three- and five-factor models. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015.*

	Monetary Momentum (1)	Times-Series Momentum (2)	Monetary Momentum (3)	Monetary Momentum (4)
Time-series Momentum	-0.030** (-2.43)		-0.0048 (-0.41)	-0.012 (-1.01)
Monetary Momentum		-0.030** (-2.43)		
Market			0.34*** (29.22)	0.37*** (28.08)
SMB			0.096*** (4.10)	0.13*** (5.21)
HML			0.13*** (6.00)	0.087*** (3.40)
Invest				0.099** (2.50)
Prof				0.14*** (4.16)
alpha	0.048*** (3.21)	0.032** (2.18)	0.035** (2.54)	0.032** (2.27)
Nobs			6,541	
Adjusted $R^2$	0.00	0.00	0.12	0.12

t-statistics in parentheses

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Table 7: Predictive Regressions

The table reports predictive regressions of federal-funds-futures-based monetary policy shocks by the cumulative returns over the previous 15 trading days. VIX high (low) includes meetings for which the VIX 15 days before the meeting was above (below) the rolling five-year average value. The sample period is from 1994 until 2019 excluding the months from January 2010 until November 2015.

	(1)	VIX High (2)	VIX Low (3)
$\prod_{s=-15:-1}(1 + r_{t+s}) - 1$	-0.0024** (-2.12)	-0.0029** (-2.32)	-0.0011 (-0.47)
Constant	-0.0016 (-0.36)	-0.0012* (-1.87)	0.0069 (1.15)
Nobs	149	71	78
Adjusted $R^2$	0.02	0.05	-0.01

t-statistics in parentheses

\* $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$