Abstract
We document a novel time-series momentum strategy around monetary policy decisions in the U.S. Stock returns drift upward preceding expansionary monetary decisions and downward before contractionary decisions. The differential pre-drift amounts to 2.5% and increases to 4.5% in the 15 days post policy decision. The differential drift is a pervasive finding across industries, international markets, other asset classes and is concentrated in times of high uncertainty.

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

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I Introduction

Monetary policy decisions trigger large reactions of asset prices. But stock markets not only react contemporaneously, they also display strong drift behavior both before and after policy announcements by the Federal Open Market Committee (FOMC) that is responsible for setting short-term policy rates. We document for the first time that US stock markets anticipate the surprise component of FOMC announcements and start appreciating 25 days before expansionary surprises, that is, meetings when the actual federal funds rate is lower than expected. Before contractionary announcements, the stock market displays negative returns - again anticipating the direction of the surprise. Not only do stock markets drift in the “correct” direction pre-announcement, they also continue to drift in the same direction post-announcement. The differential return drift is large. Before the announcement, cumulative returns differ by 2.5% until the day of the announcement and the difference increases to 4.5% in the 15 days following the announcement.

Both the pre- and post-drift are surprising. The pre-drift anticipates the actual monetary policy surprise which is based on the difference between market-implied expectations in Fed Funds Futures contracts and the actual federal funds rate that is determined on the FOMC meeting. Hence, the stock market is able to anticipate the surprise but the futures market fails to internalize these movements. The post return drift is equally surprising since it can be exploited in a trading strategy which builds on a public signal for the aggregate market rather than a subset of stocks in the cross section of equities. Taken together these two findings contribute to the literature on understanding the impact of monetary policy on asset prices and the predictable return drifts around public news announcements.

We start our sample 1994, when the FOMC changed their communication strategy and issued press releases following their policy decisions which allows us to calculate futures-based monetary policy shocks. Our sample ends in 2019 but excludes the zero-lower bound period from January 2010 through November 2015. During this sample period, we show that the differential return drift is robust to many different cuts of the
data. There is no differential drift for the classic cross-sectional factors such as value, size and momentum. However, in line with Savor and Wilson (2013, 2014), we find that high market beta portfolios display a stronger drift of about 9% vs. 3% for low beta portfolios. The Fama-French 17 industry portfolios also display a differential drift of approximately 4%. Moreover, the differential drift is robust to the precise construction of the surprises, the in- or exclusion of unscheduled FOMC meetings or turning points in policy rates.

Many international markets exhibit similar drift behavior as the US market such as the equity indices of Canada, France, Germany, Spain, Switzerland and the U.K around U.S. monetary policy decisions. Consistent with Lucca and Moench (2015), who find no pre-FOMC announcement drift for Japan, we also have a non-result for Japan. In addition, we also find drift behavior in currencies and U.S. treasuries and document similar drift behaviors to European Central Bank (ECB) monetary policy shocks, both in the Euro-Area but also in the US. The latter result is also novel because the literature so far mainly focused on the spillover of U.S. monetary policy shocks on international financial markets.

Since the monetary policy surprises are zero by construction when the ZLB is binding, we exclude it from our baseline sample. But of course, monetary policy can still affect asset prices during this period. In particular, unconventional instruments such as forward guidance and large scale asset purchase (LSAP) programs still have material impacts on markets. However, when we use the forward guidance and LSAP shocks from Swanson (2017), we find no differential drift. More generally, we do not find a differential drift whenever only soft information rather than tangible information is conveyed. We corroborate this evidence in our analysis of ECB policy surprises. We find a differential pre-drift only for the conventional ECB policy surprise but not if the shock is measured during the ECB press conference which captures a communication shock.

The post drift builds entirely on publicly available information and can thus be exploited in a trading strategy. We show an investor can increase her Sharpe ratio by a factor of four relative to buy and hold by trading on the post-announcement drift. This strategy is not spanned by traditional asset pricing factors, in particular it is distinct from the time series momentum strategy developed by Moskowitz et al. (2012), which
may appear related.

A possible risk-based explanation of the differential pre-drift may come in the form of state dependent shocks. When aggregate risk aversion is high, the FOMC might cut rates more aggressively than anticipated by market participants. We find that the monetary policy surprises tend to be more expansionary if the VIX is high in the period 15 days before the meeting relative to its five-year moving average. Virtually all of the differential pre-drift is concentrated in the times of high VIX. This finding is consistent with Neuhierl and Weber (2019) who show that the pre-FOMC announcement drift (Lucca and Moench (2015)) only occurs during times of high uncertainty.

Our analysis has important consequences for research aiming to understand the interplay of monetary policy and asset prices. The bulk of the recent literature studying this interplay focuses on 30 or 60 minute windows around the FOMC announcement to gain clean identification. Our findings indicate that focusing on narrow windows around the announcement time may in fact understate the impact of monetary policy on asset prices. Our definition of surprise follows Kuttner (2001) who constructs shocks based on the fed funds futures. When rate decision are lower than the futures implied expectation, we label this an expansionary surprise. Similarly, when actual rates are higher than expected, we label it as a contractionary surprise. It is important to note that contractionary surprises do not necessarily coincide with rate increases and expansionary surprise do not have to coincide with rate cuts. Shocks constructed in this fashion are frequently used as a source of exogenous variation in macroeconomics to study the impact of monetary policy on real quantities. Our findings call into question the exogeneous nature of these shocks.

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. Gü rkaynak, 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. 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 higher 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, Wirjadinata (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 (2020) 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, Savor, and Wilson (2020) 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).

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. 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.

Finally, our findings are reminiscent of, but distinct from, the time-series momentum strategy of Jegadeesh and Titman (2002) and 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), Alm, Conrad, and Dittmar (2003), and Sagi and Seasholes (2007).1

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.\footnote{We also exclude the rate cut on 9/17/2001 following the terrorist attacks because equity markets were closed for one week.} We discuss evidence from alternative shocks during this episode below. 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 $f f _ {t,0}$ 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 $f f _ {t,0}$ as a weighted average of the prevailing federal funds target rate, $r _ {0}$, and the expectation of the target rate after the meeting, $r _ {1}$:

$$ f f _ {t,0} = \frac{t}{D} r _ {0} + \frac{D-t}{D} E_t(r _ {1}) + \mu _ {t,0}, \quad (1) $$

where $\mu _ {t,0}$ is a risk premium.\footnote{We implicitly assume date $t$ is after the previous FOMC meeting. Meetings are typically around six to eight weeks apart.} 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:

$$ v _ {t} = \frac{D}{D-t} (f f _ {t+\Delta t+,0} - f f _ {t-\Delta t-,0}), \quad (2) $$

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

We follow Gürcaynak 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 164 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 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%.

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, $\mathcal{G}^{exp}$:

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

$\beta_0$ 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 lower.

In addition to 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. Robustness

The conduct of monetary policy has changed substantially during our sample period. To study whether our results differ pre- and post-ZLB period, we report 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 patterns in returns when we include both turning points and intermeeting policy moves. So far, we assign meeting dates with zero monetary policy shocks 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.

### D. 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.\(^5\)

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 E Figure 3 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

\(^5\)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 Chinco et al. (2020), who find that the size effect conditional on other firm characteristics is strongest in the modern sample period.
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 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).

E. 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 4 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 4). 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 4).

F. 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.\textsuperscript{6}

Figure 5 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 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.

\textbf{G. Other Asset Classes}

Previous research studies how FX markets and treasuries respond to monetary policy on the day of the announcement (Gürkaynak et al. (2005) and Mueller et al. (2017)). We now study whether we find similar pre- and post-drifts for these asset classes around FOMC announcements. Panel A of Figure 6 first studies the $/EUR exchange rate. Before the introduction of the Euro, we use the $/Deutschmark exchange rate. An increase in the rate reflects a depreciation of the dollar. Consistent with previous work, we find that loose monetary policy in the US results in a depreciation of the dollar on the day of the announcement. Surprisingly, though, we also find that the dollar also depreciates both before and after contractionary monetary policy announcements in the US.

Panel B shows the cumulative returns for 10 year Treasuries. On the day of

\textsuperscript{6}The results are also consistent with Brusa et al. (2020), 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.
the announcement, Treasuries have negative returns after expansionary shocks and
the negative returns continue for some time. Interestingly, we instead find a positive
pre-drift for treasuries before expansionary surprises starting around 25 days before the
announcement. For contractionary surprises, we find a small positive announcement effect
on the day of the FOMC meeting with little post-drift but again, we find a large pre-drift.
Starting from around 30 days before until the day of the FOMC meeting, we document
negative returns for the 10 year Treasury of around 2 percentage points.

**H. Alternative Shocks**

One potential factor driving our results are economic news coming out in the weeks
leading up to the FOMC meetings which drive the equity market reaction but also the
subsequent monetary policy decision. In fact, Bauer and Swanson (2020) argue that the
Fed’s response to economic news can explain the puzzling information effect, that is, why
equity returns react negatively to expansionary surprises on so-called intermeeting policy
moves. We follow their lead and purge the fed funds futures based measure of monetary
policy shocks with respect to both the contemporaneous and lagged Chicago Fed big data
index for real activity from Brave et al. (2019). More specifically, we use their BBK
Coincident Index which equals the sum of the leading and lagging subcomponents of the
cycle measured in standard deviation units from trend real GDP growth. Given the index
is only available at the monthly frequency we purge the monetary shocks both from the
contemporaneous and lagged value of the index. We see in Figure 7 a similar differential
pre- and post-drift around FOMC decisions independent of how we orthogonalize the
surprise shocks.

Part of our sample period is characterized by a binding ZLB of nominal interest
rates which means the Fed could not longer influence the economy via changing their
policy rate. This does, however, not imply that monetary policy is neutered and in
fact, a recent literature documents the effects of alternative policy shocks on financial
markets (Swanson (2017)). In Figure 8 we use the forward guidance and large-scale
asset purchase (LSAP) shocks of Swanson (2017) instead of the Kuttner (2001) surprises
during the binding ZLB and study whether a differential drift arises around these shocks.
Forward guidance consists of commitments by the Fed about future interest rates, whereas LSAP are announcement of bond purchase programs by the Fed. In Panel A we see no differential pre- or post-drift around forward guidance shocks, whereas Panel B shows large differential drifts around LSAP shocks. These results are consistent with the fact that announcements of future interest rate policies are hardly predictable, whereas markets typically start speculating already before the announcement about new bond purchase programs or increases in size of existing programs.

I. Euro-Area Shocks

Brusa et al. (2020) show the FOMC pre-drift of Lucca and Moench (2015) is a phenomenon that only occurs before monetary policy decisions in the US and there is no comparable result for other central banks either internationally or domestically. To study whether the differential pre- and post-drifts are also present around monetary policy decisions of other central banks, we use changes in the one-month OIS rate around the ECB monetary policy decision as well as a decomposition of these shocks into a part originating from the press release of the monetary policy decision and a part from the press conference afterwards using data from Altavilla et al. (2019) for a sample period starting in January 1999, the start of the Euro, until March of 2019.

The right panels of Figure 9 plots the differential drift for the CRSP value-weighted index and the left panels for the German DAX 30 index as a representative European stock index. In Panel A, we see a large differential pre- and post-drift for the German DAX for the overall monetary policy shock with the pre-drift cumulating to almost 4 percentage points until the day of the meeting. Surprisingly, we find a similar pre-drift of the CRSP index to the ECB policy decision and a continuation subsequently. Consistent with Brusa et al. (2020), we do not detect any pre-drift on the day before or of the actual policy decision.

Panel B shows that the part of the policy surprise that originates from the press conference which consists of introductory remarks by the ECB president explaining the policy decision and detailing the economic outlook and a subsequent Q&A with members of the press, does not results in any economically large pre- or post-drift, neither for the
European nor for the US stock index.

Finally, Panel C shows that the part of the surprise that comes from the actual policy decision relative to previous market expectations encapsulated in the OIS rate before the release drive both the differential pre- and post-drift in European and US equity markets.

These results, together with the results for forward guidance and LSAP shocks in Figure 8 suggest that markets exhibit differential pre- and post-drifts around quantitative changes in monetary policy such as changes in policy rates or changes in asset purchase programs but do not react to policy shocks originating from speeches providing guidance about future rates.

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. 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.

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7We work with daily returns, and both days cover part of that pre-FOMC drift window.
8We show below that the sign of the policy shock is predictable suggesting that some investors might in fact be able to start trading on the monetary momentum strategy already before the event day.
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 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 10 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 expansion-
ary 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 (see panel C).

Taken together, the evidence in Figure 10 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 of the 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.\textsuperscript{9}

\section{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 the real effects of \textit{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 11 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

\textsuperscript{9}We thank Stefan Nagel for inspiring this alternative interpretation.
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 -0.08 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 47 times by other contractionary shocks but also 41 times by expansionary shocks. On the other hand, contractionary shocks follow expansionary shocks 41 times, but other expansionary shocks follow 34 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.10

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 orthogonolize 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

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

10We thank Carolin Pflueger for proposing this mechanism.
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. We also find differential drifts in Treasuries and exchange rates and for different types of monetary policy shocks. Moreover, a similar drift behavior occurs before policy decisions by the ECB, both in European but also in US equity market.

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) and Hu et al. (2019).
References


Bauer, M. and E. T. Swanson (2020). The fed’s response to economic news explains the “fed information effect”.


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.
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 factors and beta-sorted portfolios 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: 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 5: Cumulative Returns around FOMC Policy Decisions: International

Panel A: German DAX
Panel B: Canadian TSX
Panel C: French CAC40
Panel D: Spanish IBEX
Panel E: Swiss SMI
Panel F: British FTSE

This figure plots cumulative returns in percent for international equity indices 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 6: Cumulative Returns around FOMC Policy Decisions: Dollar and Treasuries

Panel A: Dollar–Euro Exchange Rate

Panel B: 10 Year Treasuries

Panel A plots cumulative returns in percent of the US-Dollar – Euro exchange rate expressed in $ / EUR and Panel B plots cumulative returns in percent of 10 year treasuries around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises. Positive returns reflect a dollar depreciation. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.
Figure 7: Cumulative Returns around FOMC Policy Decisions: orthogonalized with respect to Chicago Fed Activity Index

Panel A: Contemporaneous Index

Panel B: Lagged Index

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. Panel A orthogonalizes the monetary policy shock with respect to the contemporaneous Chicago Fed Cycle Index and Panel B with respect to the lagged index. The sample period is from 1994 to 2019 excluding the months from January 2010 until November 2015.
Figure 8: Cumulative Returns around FOMC Policy Decisions: Forward Guidance and LSAP during ZLB

Panel A: Forward Guidance Shock

Panel B: Large-scale Asset Purchase Shock

Panel A plots cumulative returns in percent around FOMC policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) forward guidance shocks and Panel B for large-scale asset purchase shocks. The sample period is from January 2010 until November 2015 during the binding zero lower bound on nominal interest rates.
Figure 9: Cumulative Returns around ECB Policy Decisions: CRSP and German DAX

<table>
<thead>
<tr>
<th>German DAX</th>
<th>CRSP Value-weighted Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: ECB Overall Shock</td>
<td></td>
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<tr>
<td>Panel B: ECB Press Conference Shock</td>
<td></td>
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<tr>
<td>Panel C: ECB Press Release Shock</td>
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</table>

Panel A plots cumulative returns in percent of the CRSP value-weighted index and the cumulative returns in percent of German DAX index around ECB policy decisions separately for positive (contractionary; red-dashed line) and negative (expansionary; blue-solid line) monetary policy surprises, Panel B for monetary policy surprises around the press conference, and Panel C for monetary policy surprises around the press release. The sample period is from January 1999 to March 2019.
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 11: Bin Scatter Plot of Previous Returns and Monetary Policy Surprises

Panel A: Past 15-days Return

Panel B: VIX High

Panel C: VIX Low

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 and turning points in monetary policy.
Table 1: Monetary Policy Shocks

This table reports descriptive statistics for monetary policy shocks separately for all 164 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.

<table>
<thead>
<tr>
<th></th>
<th>All Event Days</th>
<th>Turning Points</th>
<th>Intermeeting Releases</th>
<th>VIX High</th>
<th>VIX Low</th>
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<tbody>
<tr>
<td>Mean</td>
<td>−1.34</td>
<td>−7.87</td>
<td>−16.12</td>
<td>−3.18</td>
<td>0.50</td>
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<tr>
<td>Median</td>
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<td>−1.75</td>
<td>−12.95</td>
<td>−0.54</td>
<td>0.00</td>
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<tr>
<td>Standard deviation</td>
<td>8.21</td>
<td>15.26</td>
<td>22.84</td>
<td>10.08</td>
<td>5.20</td>
</tr>
<tr>
<td>Min</td>
<td>−46.67</td>
<td>−39.30</td>
<td>−46.67</td>
<td>−46.67</td>
<td>−22.60</td>
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<tr>
<td>Max</td>
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<td>5.00</td>
<td>8.68</td>
<td>10.00</td>
<td>16.30</td>
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<td>Observations</td>
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<td>8</td>
<td>7</td>
<td>82</td>
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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.

<table>
<thead>
<tr>
<th></th>
<th>Contractionary</th>
<th>Expansionary</th>
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</thead>
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<tr>
<td>Contractionary</td>
<td>47</td>
<td>41</td>
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<tr>
<td>Expansionary</td>
<td>41</td>
<td>34</td>
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</table>
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 inter-meetings. \( \mathcal{X}^{exp} \) 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.

<table>
<thead>
<tr>
<th>( \mathcal{X}^{exp} )</th>
<th>-15</th>
<th>-10</th>
<th>-5</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>10</th>
<th>15</th>
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<tr>
<td>Panel A. Baseline</td>
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<td></td>
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<tr>
<td>( \mathcal{X}^{exp} )</td>
<td>0.05</td>
<td>0.37</td>
<td>0.99</td>
<td>1.30</td>
<td>1.62</td>
<td>1.87</td>
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<td>2.21</td>
<td>2.09</td>
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<td>(0.22)</td>
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<tr>
<td>Adjusted ( R^2 )</td>
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<td>0.00</td>
<td>0.01</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \mathcal{X}^{exp} )</td>
<td>0.28</td>
<td>0.48</td>
<td>1.38</td>
<td>1.72</td>
<td>2.17</td>
<td>3.16</td>
<td>3.23</td>
<td>3.58</td>
<td>3.89</td>
<td>3.54</td>
<td>4.87</td>
<td>4.65</td>
</tr>
<tr>
<td>(0.64)</td>
<td>(0.54)</td>
<td>(1.31)</td>
<td>(1.32)</td>
<td>(1.66)</td>
<td>(2.17)</td>
<td>(2.22)</td>
<td>(2.41)</td>
<td>(2.64)</td>
<td>(2.49)</td>
<td>(2.94)</td>
<td>(2.53)</td>
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<tr>
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<td>-0.39</td>
<td>0.04</td>
<td>-0.84</td>
<td>-0.67</td>
<td>-0.44</td>
<td>-1.09</td>
<td>-1.16</td>
<td>-1.11</td>
<td>-1.40</td>
<td>-1.35</td>
<td>-2.37</td>
<td>-1.78</td>
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<tr>
<td>(-1.00)</td>
<td>(0.06)</td>
<td>(-0.97)</td>
<td>(-0.57)</td>
<td>(-0.38)</td>
<td>(-0.82)</td>
<td>(-0.88)</td>
<td>(-0.83)</td>
<td>(-1.07)</td>
<td>(-1.11)</td>
<td>(-1.65)</td>
<td>(-1.09)</td>
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<tr>
<td>Nobs</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>-0.01</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.07</td>
<td>0.08</td>
<td>0.09</td>
<td>0.07</td>
<td>0.10</td>
<td>0.08</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>( \mathcal{X}^{exp} )</th>
<th>-15</th>
<th>-10</th>
<th>-5</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel C. VIX Low</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \mathcal{X}^{exp} )</td>
<td>-0.14</td>
<td>0.28</td>
<td>0.66</td>
<td>0.92</td>
<td>1.10</td>
<td>0.69</td>
<td>1.09</td>
<td>0.72</td>
<td>0.65</td>
<td>0.74</td>
<td>0.88</td>
<td>1.60</td>
</tr>
<tr>
<td>(−0.85)</td>
<td>(0.61)</td>
<td>(1.10)</td>
<td>(1.35)</td>
<td>(1.60)</td>
<td>(1.09)</td>
<td>(1.54)</td>
<td>(0.96)</td>
<td>(0.87)</td>
<td>(0.91)</td>
<td>(1.04)</td>
<td>(1.35)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.29*</td>
<td>0.34</td>
<td>0.35</td>
<td>-0.05</td>
<td>-0.03</td>
<td>0.35</td>
<td>0.01</td>
<td>0.16</td>
<td>0.18</td>
<td>0.12</td>
<td>0.17</td>
<td>-0.11</td>
</tr>
<tr>
<td>(1.98)</td>
<td>(0.81)</td>
<td>(0.46)</td>
<td>(-0.08)</td>
<td>(-0.05)</td>
<td>(0.63)</td>
<td>(0.02)</td>
<td>(0.25)</td>
<td>(0.29)</td>
<td>(0.17)</td>
<td>(0.24)</td>
<td>(-0.10)</td>
<td></td>
</tr>
<tr>
<td>Nobs</td>
<td>81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>

\( t \)-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. $D^{exp}$ 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.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D^{exp}$</td>
<td>0.27</td>
<td>0.51*</td>
<td>0.50</td>
<td>0.59</td>
<td>0.45</td>
<td>1.16**</td>
<td>1.44**</td>
</tr>
<tr>
<td></td>
<td>(1.27)</td>
<td>(1.76)</td>
<td>(1.44)</td>
<td>(1.58)</td>
<td>(1.08)</td>
<td>(2.36)</td>
<td>(2.26)</td>
</tr>
<tr>
<td>Constant</td>
<td>−0.11</td>
<td>−0.32</td>
<td>−0.22</td>
<td>−0.34</td>
<td>−0.33</td>
<td>−0.82**</td>
<td>−0.70</td>
</tr>
<tr>
<td></td>
<td>(−0.65)</td>
<td>(−1.34)</td>
<td>(−0.79)</td>
<td>(−1.10)</td>
<td>(−0.98)</td>
<td>(−2.02)</td>
<td>(−1.33)</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Panel A. Market and Monetary Momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t-15 ) – ( t+15 )</td>
</tr>
<tr>
<td>( \text{Buy and Monetary} )</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel A2. 1994–2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel A3. 2015–2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS Mom</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B3. 2015–2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Std</td>
</tr>
<tr>
<td>( \text{SR}_{\text{annualized}} )</td>
</tr>
</tbody>
</table>
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.

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

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 and turning points in monetary policy.

<table>
<thead>
<tr>
<th></th>
<th>VIX High</th>
<th>VIX Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>$\Pi_{s=-15-1}(1 + r_{t+s}) - 1$</td>
<td>-0.0024**</td>
<td>-0.0029**</td>
</tr>
<tr>
<td></td>
<td>(-2.12)</td>
<td>(-2.32)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0016</td>
<td>-0.0012*</td>
</tr>
<tr>
<td></td>
<td>(-0.36)</td>
<td>(-1.87)</td>
</tr>
<tr>
<td>Nobs</td>
<td>149</td>
<td>71</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.02</td>
<td>0.05</td>
</tr>
</tbody>
</table>

T-statistics in parentheses

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