Stock Market Uncertainty and the Federal Open Market Committee Cycle

Master's Thesis

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Abstract

Federal Open Market Committee (FOMC) meetings begin a biweekly cycle of high excess stock returns in the U.S. market. Even week days, based on the date of the previous FOMC meeting, enjoy high returns while odd numbered weeks perform poorly. This FOMC cycle is responsible for the whole equity premium during 1994-2019. In this study we find empirical evidence that the FOMC cycle is driven by stock market uncertainty. High-uncertainty years witness a particularly high premium, while low uncertainty periods show no such premium. Among the most uncertain quartile of days, based on the CBOE Volatility Index (VIX), even week days command a premium of over 30 basis points, whereas in the low-VIX sample the difference is not statistically different from zero. We back these findings by showing that the Fed's behavior changes during high uncertainty periods. Policy changes are more accommodative and communication is more abundant. Furthermore, investors' attention towards the Fed is increased. Our results have implications for the investors, policymakers and the society.

Keywords central bank communication, central bank information effects, implied volatility, uncertainty, Federal Open Market Committee, equity risk premium

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Tiivistelmä
Yhdysvaltojen keskuspankin avomarkkinakomitean kokoukset aloittavat vuoroviikkoisen syklin korkeille osaketuotoille Yhdysvaltain markkinoilla. Parillisten viikkojen päivinä, avomarkkinakomitean edellisestä kokouksesta laskettuna, tuotot ovat korkeita kun taas parittomien viikkojen päivinä tuotot ovat matalia. Tämä sykli selittää kokonaan osakkeiden ylituoton suhteessa riskittömään korkoon vuosina 1994-2019. Tässä tutkimuksessa löydämme empiirisiä todisteita sille, että avomarkkinakomitean sykliä ajaa osakemarkkinoiden epävarmuus. Korkean epävarmuuden vuosina parillisten päivien preemio on erittäin korkea, kun taas matalan epävarmuuden aikoina preemiota ei ole. Kaikkein epävarmimpina päivinä, mitattuna CBOE:n volatiliteetti-indeksillä (VIX), parillisten viikkojen päivät tuottavat yli 0,3% enemmän kuin parittomat päivät. Matalan epävarmuuden päivinä tuottoerot eivät ole tilastollisesti merkitseviä. Tuemme löydöksiämme esittämällä todisteita siitä, että Yhdysvaltojen keskuspankin käytös muuttuu korkean epävarmuuden aikoina. Rahapolitiikan muutokset ovat todennäköisemmmin elvyttäviä ja kommunikaatio on runsaampaa. Lisäksi, sijoittajien mielenkiinto keskuspankkia kohtaan on korkeammalla. Tuloksemme koskettavat sijoittajia, viranomaisia ja koko yhteiskuntaa.

Avainsanat epävarmuus, osaketuotot, keskuspankki, keskuspankin kommunikaatio, VIX, avomarkkinakomitea

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1. Introduction

During uncertain times anxious investors often turn to the central banks for reassurance. The global COVID-19 pandemic is just one example of crisis that the financial markets have witnessed in recent decades. Among central banks, the U.S. Federal Reserve (Fed) enjoys a unique position, as no other institution matches it in influence over the financial markets (Brusa, Savor, & Wilson, 2020). Could Fed's grip of the stock market be so strong that during market turmoil all of the equity premium is driven by its policies? In this study we look at how information, which flows regularly from the Fed to the stock market, affects U.S. stock market excess returns. In particular, we are interested in how this effect on stock prices varies by the prevailing level of market uncertainty.

The FOMC cycle even week premium is a recently documented phenomenon which affects both U.S. and global stock markets. The Federal Open Market Committee (FOMC) is the committee of the Federal Reserve which is responsible for open market operations. The operations affect the interest rate at which depository institutions lend their balances at the Federal Reserve to other depository institutions overnight (Federal Reserve, 2020). The FOMC holds eight scheduled meetings annually. At the meetings, the committee reviews economic and financial conditions, and determines the appropriate stance of monetary policy. According to Cieslak, Morse, and Vissing-Jorgensen (2019), informal communication between the Fed and the market participants causes stock markets to move. Because Fed's decision making takes place predominantly during every other week, prices also move every other week. Cieslak et al. (2019) find that excess stock returns seem to follow a biweekly pattern, where returns are high every other week, starting from a FOMC monetary policy meeting. On other days, combined excess returns are close to zero. The difference between the two constitutes the even week premium.

Our main finding is that the magnitude of the FOMC even week premium is manifold during times of uncertainty. In fact, a large share of the effect is caused by the days that fall under the most uncertain quartile, as measured by option-implied volatility (VIX), in the sample period of 1994 to 2019. We use an ordinary least squares (OLS) regression model and find that the average excess return for days in week 0 and the other even cycle weeks are 33.6 bps and 31.6 bps higher, respectively, than other days during this time. These results are significant at the 1% level. Conversely, we fail to find evidence of the FOMC even week premium

for many of the years in our 1994-2019 sample period. The years which lack the effect tend to be characterized by low levels of uncertainty. These novel results are robust to various announcement, calendar and stock return control variables presented in past literature.

We argue that the uncertainty-driven even week effect is caused by three main factors which affect the quality and quantity of information sharing between the Fed and the stock market. First, investors' attention towards the Fed is increased during times of heightened uncertainty. Thus, they may react more strongly to new information. Second, the FOMC tends to make more accommodative policy decisions during heightened uncertainty. Finally, the Fed interacts more actively with market participants during times when they are most desperate for information. In our analysis we provide backing for each of these claims. We find that the interest in the Federal Reserve, as measured by Google search volume, is significantly higher during times of high uncertainty. Likewise, we find that federal funds target rate changes are more likely cuts during times of high uncertainty: the average target rate change after a period of high uncertainty is -34.7 bps, whereas after low uncertainty the average change is +22.2 bps. Lastly, the number of press releases given out by the Fed increases considerably with the markets' uncertainty levels. An increase of 20 points in VIX increases the number of press releases by 5.4 during the next four weeks. Thus, it seems likely that the biweekly excess return in the stock market, caused by the information disseminated by Fed to the market participants, is also affected.

In addition, we look at whether a similar uncertainty driven cycle effect could be present for the European Central Bank (ECB) and the European equity market. Furthermore, we expand our initial sample to cover the first half of 2020 and the accompanying market distress brought on by the COVID-19 pandemic.

Our findings are relevant both to the investor and the society at large. If uncertainty increases the role of the Fed substantially, investors might need to contemplate their investment strategies. Furthermore, if access to informal monetary policy information can help produce exceptional returns, those left outside the inner circle might question their trust in the fairness of the markets. Especially, retail and foreign investors might be at risk. Finally, the central bankers might need to consider how the enormous role that financial markets are readily willing to cast them at times of uncertainty might affect the way they should form and communicate future policies. An excess fixation on the Fed might reduce investors' focus

on the real economy and company fundamentals and lead to mispricing, bubbles and consequent crashes, which have detrimental effects on the society.

The rest of this paper is organized as follows: in section 2 we review the most integral literature related to our topic. Furthermore, we discuss our hypotheses. In section 3, we derive our hypotheses. Section 4 explains the functioning of the Federal Open Market Committee, and the data that we use in our analysis. In section 5, we present our main results about uncertainty and the FOMC cycle. Moreover, we shed light into the causality between uncertainty and the FOMC cycle through additional analysis. Section 6 widens our scope to the ECB and the European market. Section 7 concludes.

1.1 Contribution to Existing Literature

The FOMC cycle has not been extensively studied. Cieslak et al. (2019) report it for the first time, and only a few working papers have later addressed it. Our study contributes to the existing research in three ways. First, we have the opportunity to expand the data set to cover the three additional years that have passed since the release of the initial paper. In fact, these three years seem to matter. Our analysis suggests that the FOMC cycle has weakened in recent years, contrary to findings of Cieslak et al. (2019). Similarly as with the disappearing FOMC pre-announcement drift documented by e.g. Kurov, Wolfe, and Gilbert (2019), we argue that this is due to decreased uncertainty. In fact, we find that uncertainty, as measured by the level of the VIX, has a statistically significant effect on the magnitude of the FOMC cycle, across the whole 1994-2019 sample. This effect is robust to stock market returns, other macroeconomic and earnings announcements, and various calendar effects reported in literature. It also explains why we fail to find evidence of the cycle in many years.

We also conduct novel analysis on the causation between VIX and the FOMC cycle. We employ Google search volume data to study how VIX affects investors' interest towards the Fed. We also use data from the Federal Reserve to study the relationship between VIX and Fed's policy decisions and communication with the markets. Our study is the first to extensively study the relationship between the level of VIX and the magnitude of the FOMC cycle. Consequently, our study helps to better understand the complicated relationship between the Federal Reserve and the stock market.

2. Literature Review

FOMC cycle is one of the latest additions to financial research papers that study macroeconomic announcements and their effect on the stock market. Already prior to Cieslak et al. (2019), researchers have found evidence of links between stock market excess returns and macroeconomic announcements. Among macro announcements, the FOMC has been a popular topic of research (see e.g. Ernst, Gilbert, and Hrdlicka (2019); Lucca and Moench (2015)). Next we present the most integral findings in related literature which give the necessary context to interpret the findings of this study.

2.1 Macroeconomic Announcements and Stock Returns

Investors follow macroeconomic data, such as unemployment, economic growth and interest rates to understand the state of the economy. Although many macroeconomic news arrive over time at random intervals, a significant share of news is released at prescheduled dates which investors can know up to months beforehand. If asset prices react to these news, holding assets around these announcements increases the risk for the investor (Savor & Wilson, 2013). Consequently, the macroeconomic risk associated with this macroeconomic information should be resolved at the time of the announcement. This is when the bearer of the risk should also earn their return (Ernst et al., 2019).

Previous literature finds evidence for an announcement premium, as multiple studies find that stock returns are relatively high on macroeconomic announcement days. In fact, a significant share of equity premium can be earned on macroeconomic announcement days only. Savor and Wilson (2013) find that 60% of equity premium is earned on days when unemployment, inflation and interest rates are announced. These announcement days cover a mere 13% of all trading days. They find that average excess market returns are 11.4 basis points (bps) on announcement days versus 1.1 bps for other days. They further find that realized volatility is only 4% higher on announcement days. Thus, Sharpe ratios are around 10 times higher on announcement days.

Ernst et al. (2019) are possibly the first ones to study the announcement days of virtually all of the important macroeconomic variables simultaneously. They show that many combinations of macroeconomic variables together explain up to 100% of equity premium. However, they argue that high ex-post returns are

not necessarily signs of high ex-ante importance of the announcements. In other words, the high returns which have been witnessed around macro announcements could be due to some other reason than the "specialty" of the announcements. In fact, when all the macroeconomic announcements are considered together as a group, and day-of-the-month fixed effects are controlled, the announcement days as a group explain roughly half (56%) of the equity premium. In addition, this premium is earned during 62% of trading days. Thus, they argue that the announcement days are not so "special" after all.

Ernst et al. (2019) also find that variables such as construction spending, FOMC, unemployment rate, consumer confidence and new home sales are among the most "powerful" variables, i.e. these variables witness high returns on announcement days. Among these, the FOMC seems to stand out from the rest in terms of magnitude. They contemplate whether the FOMC is unique because unlike the other figures, FOMC is not only a summary of past events. Instead, it gives information about future actions as well. Due to this forward-looking nature of the FOMC its content could be more valuable to investors.

2.2 FOMC Announcements and Stock Returns

As the past decade has shown, central bank policies matter to investors. Numerous news articles, analysts and investment professionals follow central banks' actions. One way for central banks to convey their policies is through interest rate decisions. In the U.S., Federal Open Market Committee's (FOMC) interest rate decisions cause strong reactions in equity markets (Bernanke & Kuttner, 2005). Members of the FOMC meet regularly to discuss and make monetary policy decisions. Since the early 1980s there has been eight meetings per year and since 1994 the decisions have been announced publicly in the afternoon of the day of the meeting (Lucca & Moench, 2015).

2.2.1 *FOMC Pre-Announcement Drift*

Previous literature shows that a large share of the stock market appreciation around FOMC meetings takes place already before the announcements. Lucca and Moench (2015) find that between 1994 and 2011, 80% of equity premium was earned during the 24-hour window right before the FOMC announcements. These returns do not reverse after the meeting. Lucca and Moench (2015) also show that a similar FOMC pre-announcement drift is found in foreign major stock markets as well. Their results are robust to different industry and firm size portfolios.

They also report that other macroeconomic announcements do not feature similar pre-announcement drifts.

Lucca and Moench (2018) test whether the pre-announcement drift still exists in a later sample. They use a post-2011 sample to study if there has been any changes in the effect. They find that only FOMC announcements that are followed by a press conference from the Chairman display a significant, positive pre-announcement drift. For other FOMC announcements, there is no pre-announcement drift anymore. Instead, there seems to exist a negative post-announcement drift, although it is not statistically significant. They argue that investors have discounted the value of meetings which do not include press conferences, as policy rate changes and Summary of Economic Projections (SEP) releases have taken place only at meetings with a press conference since 2011. Thus, the amount of information releases from a meeting without a press conference is limited.

2.2.2 *FOMC Announcements and Global Stock Returns*

Brusa et al. (2020) find that foreign stock markets exhibit similar reactions to the FOMC meetings as the US market. They test thirty-seven markets and find that in twenty-six of those, including the U.S., there is a statistically significant positive reaction to FOMC meetings. Surprisingly, they find that other major central banks do not appear to have a similar effect on their local market, let alone the global stock market. Neither the European Central Bank, Bank of England nor Bank of Japan have a statistically significant effect of their respective stock markets on the announcement day. The authors suggest that the Fed enjoys a unique position as the leader of the world's central banks. As such, we direct most our focus in this paper to Fed, due to its dominant position among central banks.

2.3 FOMC cycle and Stock Returns

Recent research has identified also other, more complicated return patterns related to the FOMC announcements. Cieslak et al. (2019) find that average stock returns follow a biweekly cycle, starting from a FOMC meeting. FOMC meetings last usually one or two days. Week 0 begins one day prior to the day when a FOMC announcement is scheduled, which is the last day of a FOMC meeting in case of a two-day meeting. Starting from that they, the first five trading days belong to week 0, the next five to week 1, and so forth. They report that during 1994-2016, the entire equity premium was earned on weeks 0, 2, 4 and 6 in the so-called FOMC cycle time. Thus, excess returns in aggregate are virtually zero on the other

weeks. This effect is robust to reserve maintenance periods, other macro releases, the public speeches of Fed members and companies' earnings announcements. The authors causally tie this pattern to the biweekly flow of informal information from the Fed to market participants. They show that the Federal Reserve's Board of Governors meetings take place disproportionately during even weeks in FOMC cycle time. For these meetings, the regional Federal Banks submit their requests for discount rate changes and they act as venues for open discussion and exchange of ideas. Furthermore, Cieslak et al. (2019) find evidence that the timing of the Board of Governors meetings is strongly related to intermeeting target changes, which usually take place during even weeks in FOMC cycle time. Consequently, they find that federal funds futures rates decline significantly during even weeks, which is in line with the accommodating monetary policy during 1994-2016. Finally, in addition to the U.S. market, they also find evidence of a similar FOMC driven cycle in other developed countries' stock markets, as well as in emerging markets.

2.3.1 *Uncertainty and FOMC Cycle*

Our study focuses largely on the relationship between uncertainty and the FOMC cycle. Cieslak et al. (2019) argue that one channel by which Fed affects the stock market, is via reducing downside risk. In other words, Fed promises to keep policy rates low and use other measures at its disposal if the economic development is poor. Furthermore, the need to reduce downside risk is highest at times of high uncertainty. Cieslak et al. (2019) show that the even week premium is higher after stock market declines. This is in line with a "Fed put" theory, in which the central bank reacts to negative stock returns with accommodative policy. However, stock returns are only one indicator which the Fed could use to evaluate level of uncertainty. Martello and Ribeiro (2018) find in their working paper that uncertainty affects the magnitude of the FOMC pre-announcement drift. They also suggest a similar trend with the FOMC cycle but do not show any statistical evidence. Multiple authors have previously used VIX as a measure for stock market uncertainty. Lucca and Moench (2015) find that the FOMC pre-announcement drift is stronger when values of lagged VIX are high. They use VIX as a proxy for equity market uncertainty. Hu, Pan, Wang, and Zhu (2019) find that stock returns in the US are high after sudden increases in VIX and after high levels of VIX. They argue that VIX is a reasonable proxy for market uncertainty, as it is forward looking and has been widely used as the market's "fear gauge". Inspired by these studies, we too use VIX as our main measure of uncertainty.

We will also devote some attention to the ECB monetary policy meeting cycle, as despite the apparent absence of ECB monetary policy meeting premiums document by Brusa et al. (2020) on standard times, there seems to be evidence of an economically and statistically large 24h pre-ECB announcement returns in European equity during the period of European sovereign debt crisis between the years 2010-2015 (Ulrich, Jakobs, May, & Landwehr, 2017). Ulrich et al. (2017) also document that the effect is stronger in e.g. European banking and financial services sectors as well as cyclical industries like the automotive sector. Furthermore, the effect seems to be concentrated on euro-peripheral countries and likewise seems to mean revert back to zero within two hours of the announcement, making it indistinguishable when looking at daily returns.

3. Hypothesis Development

Cieslak et al. (2019) attribute the FOMC cycle to the biweekly information flow from the FOMC to the stock market. They control for e.g. macroeconomic and company earnings announcement dates as well as dates of other Fed releases. We want to confirm that the even week premium is still present with an extended sample period by conducting a similar analysis. We expect the results to remain largely similar. Thus, our first hypothesis is:

> *Hypothesis 1: US stocks experience above average returns on weeks 0, 2, 4 and 6 in FOMC cycle time*

Uncertainty is known to affect excess stock returns around FOMC meetings. FOMC pre-announcement drift correlates positively with lagged values of VIX (Lucca & Moench, 2015) and weakens in post-2011 data (Kurov et al., 2019; Martello & Ribeiro, 2018). The authors attribute this to reduced uncertainty. We suspect that a similar effect could be associated with the FOMC cycle. In other words, we claim that the importance of Fed to the investors is elevated during periods of high uncertainty. Thus, our next hypothesis is:

> *Hypothesis 2: Level of uncertainty has a positive relationship with the even-week premium*

In order to shed light on the causation between uncertainty and the FOMC cycle, we test three possible explanations for how high values of uncertainty would translate into a stronger even week premium:

> *Hypothesis 3a: Investors' interest in Fed increases during times of high uncertainty*
>
> *Hypothesis 3b: Fed makes more accommodative policy decisions during periods of high uncertainty*
>
> *Hypothesis 3c: Fed communicates to the market more actively during times of high uncertainty*

Hypothesis 1 has already been tested in prior literature and our objective in this study is simply to validate its existence. In contrast, hypothesis 2, according to our knowledge, has not been the focus of any research paper. Furthermore, the three last hypotheses are unique to this study.

4. Data

The main focus of this paper is to, first, confirm the existence of the FOMC cycle effect documented by Cieslak et al. (2019) and, second, decipher the impact that uncertainty plays in its intermediation. Therefore, we collect the relevant central bank and market data.

4.1 Central Bank Meetings

4.1.1 *Federal Reserve*

To assess the impact of central bank meetings, we collect dates of the Federal Open Market Committee (FOMC), meetings starting from the year 1990. The dates are obtained straight from the Federal Reserve's website. "FOMC is comprised of twelve members including the seven members of the Board of Governors of the Federal Reserve System; the president of the Federal Reserve Bank of New York; and four of the remaining eleven Reserve Bank presidents, who serve one-year terms on a rotating basis. FOMC is responsible for Fed's open market operations and in its meetings, the Committee reviews economic and financial conditions, determines the appropriate stance of monetary policy, and assesses the risks to its long-run goals of price stability and sustainable economic growth." (Federal Reserve, 2020)

Since 1981, the Fed has held eight scheduled meetings per year roughly six to eight weeks apart. However, only after February 1994 has the Fed publicly announced their decisions following a FOMC meeting via prescheduled statement (Cieslak et al., 2019). The statements are released in the afternoon of the final day of the meeting with the release time being 2:15 pm prior to April 2011 and has since then varied between 12:30 pm and 2 pm (Brusa et al., 2020). Furthermore, since 2011, the Chair of the FOMC has been giving a press conference at every other FOMC meeting. In addition, in these same meetings the FOMC releases the summary of its members' economic projections (SEP). As such, these meetings include three distinct releases: the FOMC statement, the SEP, and the press conference with the Chair (Lucca & Moench, 2018). Based on this information, we will focus largely on the period post-1994.

We then follow the rationale of Cieslak et al. (2019) and assign each business day in the period between two meetings to a corresponding week and form the so

called FOMC cycle. Marking the day of the meeting as day 0[1], we define week -1 in the cycle as days -6 to -2, week 0 as days -1 to 3, week 1 as days 4 to 8 and so forth until week 6 which includes days 29 to 33. Therefore, each cycle week includes five calendar days and can span over two calendar weeks.

Figure 1 presents the total number of days in each cycle week following the above described cycle construction as defined by Cieslak et al. (2019). Later cycle weeks witness a significant drop in days, especially weeks 5 and 6. We also show an alternate cycle structure in which we exclude week -1. This increases the number of days in the later cycle weeks noticeably, especially for weeks 5 and 6. However, following Cieslak et al. (2019), we include week -1 in our analysis in the later sections of this paper.

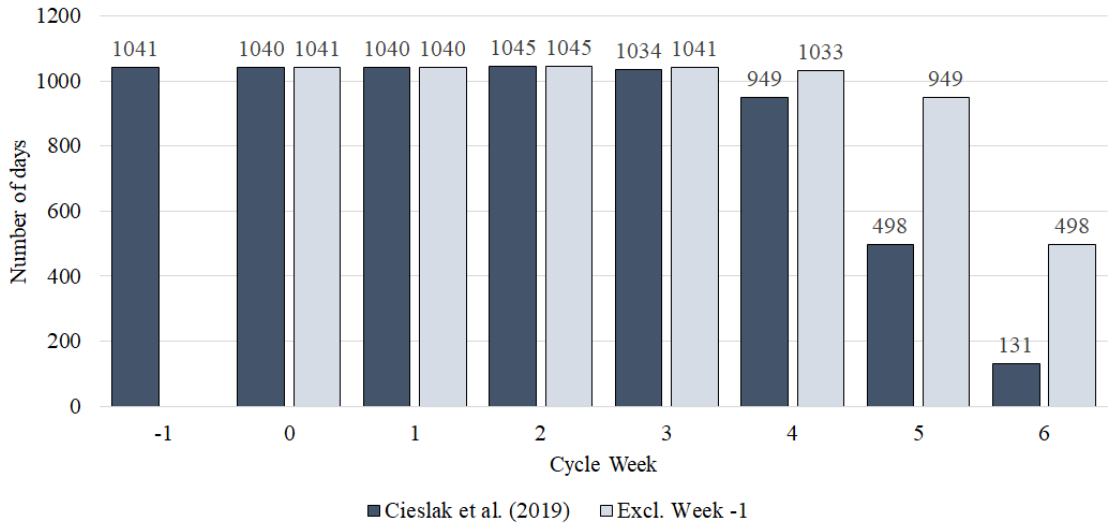

Figure 1: Number of Days per FOMC Cycle Week, 1994-2019

This figure presents the bar chart of number of days that fall on each FOMC cycle week. We show the numbers based on two alternative cycle constructions: including and excluding week -1. The 1994-2019 sample covers 209 FOMC meetings.

4.1.2 *European Central Bank*

The European Central Bank (ECB) was established in June 1998 and started operating in full extent from January 1999 onwards (Brusa et al., 2020). ECB's main decision-making body is the Governing Council, which consists of the six members of the executive board as well as the governors of the national central banks of the 19 euro area countries. The council's responsibilities are threefold consisting of

[1]For two-day meetings, the latter of the dates is used as day zero in the cycle as it includes release of the statement

ensuring that tasks entrusted to ECB and Eurosystem are achieved, formulating the monetary policy of the Eurosystem as well as, more recently, responsibilities related to banking supervision. These days, the Governing Council meets twice a month at the ECB's premises in Frankfurt am Main, Germany. However, decisions regarding monetary policy are taken in meetings every six weeks while the rest of the meetings concentrate on the other tasks (European Central Bank, 2020). Our focus in this paper is on these monetary policy meetings.

In its early days, ECB held monetary policy meetings twice per month but in November 2001 switched to one monthly meeting. In January 2015, the current 6-week monetary policy cycle was put into force. Following the monetary policy meetings, the ECB releases its decision through a press release at 1:45 pm Central European time on the same day (Brusa et al., 2020). In addition, the ECB publishes regular accounts of the Governing Council's monetary policy meetings prior to the date of the next one.

As such, we collect the dates of the monetary policy meetings and respective press releases directly from ECB's website for the years 2002 to 2019. We exclude the first few years in the beginning of the banks inception due to the shorter meeting cycle. From 2002 up until the adoption of the current meeting cycle in 2015, the ECB governing council had monetary policy meetings once per month. A representative from ECB also confirmed that the Governing Council held another non-monetary policy meeting two weeks after each of the monetary policy meetings. We then form an ECB monetary policy cycle following the same logic as detailed above for FOMC.

4.2 Market Data

In order to determine the impact of FOMC meetings and the respective cycle to the equity market, we obtain CRSP value-weighted market index from Kenneth French's website along with the one-month Treasury bill rate. We use these as the daily market return, $r_{m,t}$, and daily risk-free rate, $r_{f,t}$, respectively and by extension derive the market's excess return:

$$r_t^e = r_{m,t} - r_{f,t} \tag{1}$$

In order to determine the role of uncertainty in the FOMC cycle effect, we collect

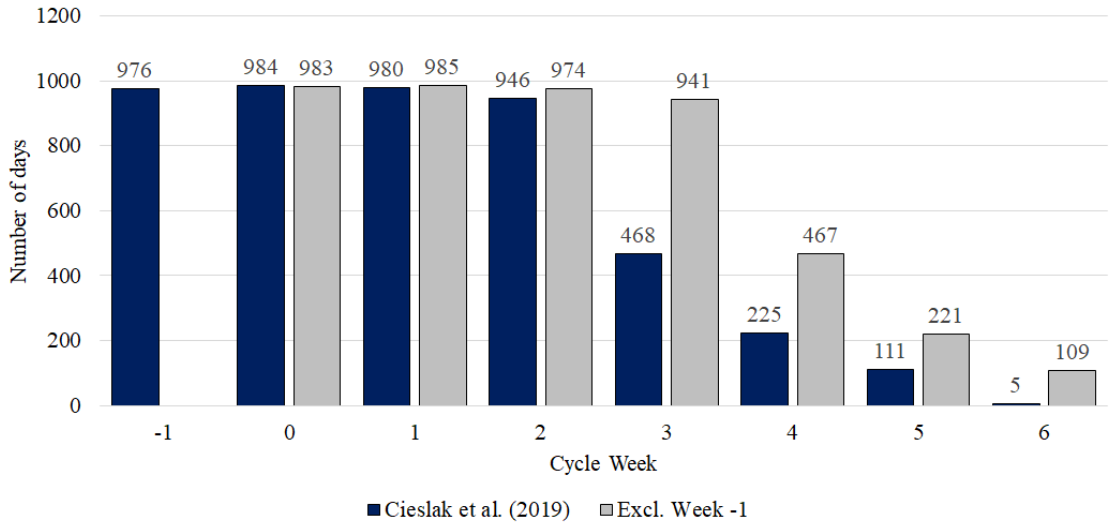

Figure 2: Number of Days per ECB Cycle Week, 2002-2019
This figure presents the bar chart of number of days that fall on each ECB monetary policy cycle week. We show the numbers based on two alternative cycle constructions: including and excluding week -1. The 2002-2019 sample covers 197 ECB governing council monetary policy meetings.

VIX Implied Volatility Index and the 10-year U.S. Treasury Note Volatility Index TYVIX from Chicago Board Options Exchange (CBOE). These have been used as market-based uncertainty measures for market conditions and monetary policy uncertainty (Gu, Kurov, & Wolfe, 2018; Kurov et al., 2019).

Similarly, we obtain the EURO STOXX 600 total return index from Datastream as base stock returns for Europe and use 3-month Euro area yield curve for AAA-rated countries (post 9/2004) and 1-year German Bund rate (pre-2004) as the basis for the daily risk-free rate to calculate the daily Eurozone excess equity return. The rates are obtained from ECB statistics site and Refinitiv Datastream respectively. We also collect daily values for the EURO STOXX 50 Volatility Index (VSTOXX) to be used as a proxy for market uncertainty. The values are obtained directly from STOXX.com website.

4.3 Other Macroeconomic Releases

In addition to the FOMC cycle, several other macroeconomic announcements have been documented to impact the equity market. Following on the footsteps of Ernst et al. (2019), we collect the most prominent of these announcements in order to reduce the probability of the omitted variable bias. The selected variables are presented in Table I.

Table I: Macroeconomic Announcements

This table presents summary of the macroeconomic announcements that are used as control variables. The announcement dates are obtained for years 1994-2019 and include 312 monthly releases. We choose the announcements based on their impact on equity premium as documented by Ernst et al. (2019).

Variable	Source	Percent of Equity Premium
Construction Spending	Census Bureau	36.2%
NAPM	Institute for Supply Management	29.2%
Consumer Confidence	The Conference Board	18.8%
New Home Sales	Census Bureau	16.6%
Housing Starts	Census Bureau	16.0%
Unemployment Rate	Bureau of Labor Statistics	14.3%
UM Consumer Confidence F	University of Michigan	13.3%

5. Analysis & Discussion

5.1 Replicating Cieslask et al. (2019)

We begin our analysis by replicating the main results of Cieslak et al. (2019). We also test their conclusion of a strengthening even week premium by expanding their sample to cover three additional years, 2017 to 2019. We start by testing whether stock market excess returns during even and odd weeks in FOMC cycle time indeed do differ significantly. We allocate each trading day in 1994-2019 to either an even week (weeks 0, 2, 4, 6) or odd week (weeks -1, 1, 3, 5) based on the FOMC cycle. Then we calculate the excess returns for each day as the difference between the market return and the risk-free return. Finally, we calculate the average daily excess return for even weeks and odd weeks. The total number of trading days during 1994-2019 is 6,782, of which 3,165 occur during even weeks and 3617 during odd weeks in FOMC cycle time. The reason for such a difference in days is due to the varying length between two FOMC monetary policy meetings. The first week in the cycle, -1, is always odd. Thus, on average there are more odd than even days in a cycle, as for every even week there is at least as many odd weeks in the cycle.

We find that the average daily excess return during even weeks has been 8.2 basis points (bps), whereas the average daily excess return during odd weeks has actually been negative, at -0.9 bps. The difference in average daily returns is economically very significant, 9.2 bps. During the previous 26 years the even weeks are responsible for more than 100% of the equity premium in the United States. We use a two-sample t-test to find out whether the two averages are statistically significant. The difference is significant at the 1% level. An U.S. investor could have "beaten" the market by holding risky assets on only around 40% of trading days. Thus, the even week premium is economically very significant. These results are in support of hypothesis 1, which states that stock returns are above average during even weeks in FOMC cycle time.

As mentioned earlier, a single FOMC cycle can last up to 8 weeks (-1 to 6). Thus, it is also of interest whether the difference between even and odd week returns are concentrated on certain days or weeks in cycle time. In the spirit of Cieslak et al. (2019), in Figure 3 we have calculated the average 5-day cumulative excess returns for each day in the FOMC cycle, starting from day -6 all the way up to day 33. The thick blue line represents the full 1994-2019 sample, while the lighter dashed line

Table II: Average daily excess return by cycle week, 1994-2019

This table presents the average daily excess stock market returns for even and odd week days in FOMC cycle time. The sample covers years 1994 through 2019. The significance of the difference is calculated with a two-way t-test. In this and subsequent tables, ***/**/* indicates significance at the 1%/5%/10% level.

	Even week	Odd week	Difference
Mean	0.082	-0.009	0.092***
Std. dev.	1.159	1.083	
N	3,165	3,617	

represents the 1994-2016 sample, which is similar to the one used by Cieslak et al. (2019). Day 0 marks the day of the monetary policy meeting. In case of a two-day meeting, day 0 is the second day, on which policy announcements are made. The cumulative returns on the vertical axis cover days t to t + 4. Weekends are not included in the sample, and for holidays we have set the return at zero. Thus, five days in the graph represent a full calendar week on average.

As Cieslak et al. (2019), we find a biweekly pattern in the US stock market, starting from the week prior to the FOMC meeting. Again, this is in line with hypothesis 1. The shape of the pattern is almost identical to that of the earlier study. Every odd week delivers low or negative returns, while the even weeks have high average returns. It is worthwhile to note how similar in magnitude all the even weeks are. Thus, no single day or week is driving the impact alone. Week 6 (days 29-33) has the highest cumulative return, although the small sample size means that the effect is not as economically significant. As noted earlier in Figure 1, weeks -1 through week 3 include more than 1,000 trading days each, while for week 6 the number is significantly lower at 131. Also all odd weeks have quite similar average returns, with week 1 (days 4-8) having the lowest return.

Adding three more years (2017-2019) to the data set seems to weaken, not strengthen, the biweekly cycle. Most of the peaks slightly flatten compared to the shorter sample which ends to 2016. This is contrary to what Cieslak et al. (2019) suggested but in line with our own expectations. The recent years have been relatively stable and lacked major uncertainty as measured by VIX which, according to our hypothesis, is a key driver of the FOMC cycle.

Next we add a layer of statistical robustness to our analysis. In order to asses the statistical significance of the results we attained in Figure 3, we estimate the following regression model:

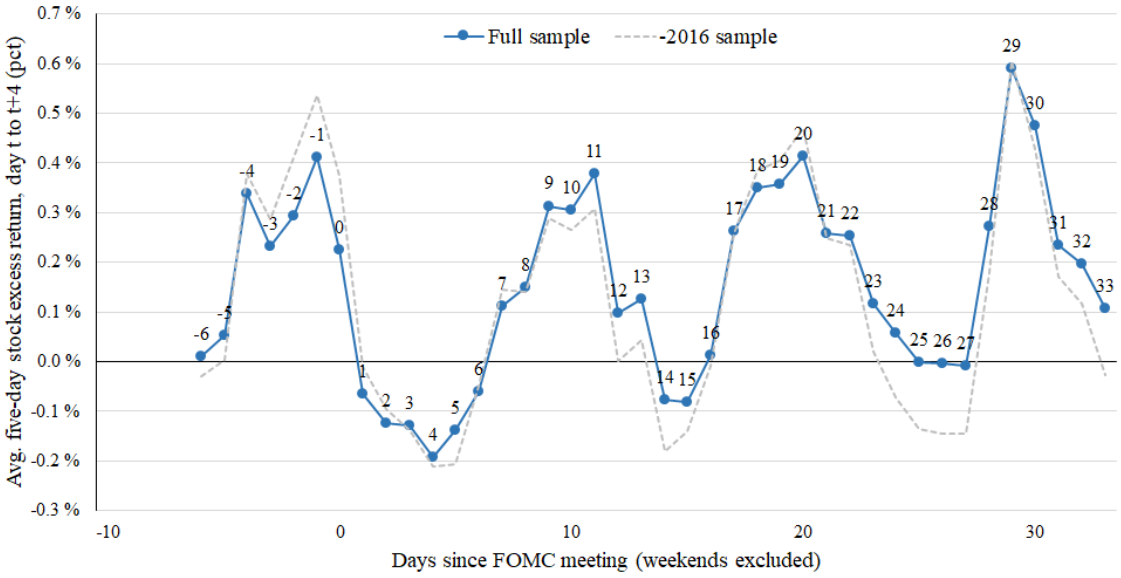

Figure 3: Avg. 5-day Excess Return During FOMC Cycle, 1994-2019
The plot is based on data covering 209 FOMC cycles. The numbers along the line indicate the value on the horizontal axis. The solid line marks the full 1994-2019 sample, while the dashed line represents sample 1994-2016.

$$r_t^e = \beta_0 + \beta_1 EvenWeekDummy_t + \epsilon_t \tag{2}$$

, in which r_t^e is the excess return of stocks over T-bills in time t and $EvenWeekDummy_t$ is dummy variable that has the value of one for each day of the respective FOMC cycle week. The weeks are determined following the cycle constructions introduced by Cieslak et al. (2019). Table III presents the results of Equation (2) on various levels of aggregation for the FOMC cycle week dummy. Panel A presents the results for the original sample used by Cieslak et al. (2019)[2]. Panel B expands the sample to cover the three additional years until end of 2019. In columns (1) and (4) the dummy variable differentiates only between even and odd weeks. In columns (2) and (5) we further separate week 0 from the rest of the even weeks. Finally, in columns (3) and (6) we mark each even week with their separate dummy variable.

The results tell a similar story to that of Figure 3: days which occur during even weeks in FOMC cycle time seem to enjoy higher returns on average, but to a

[2]Slight deviation to original results are likely caused by inclusion of three additional sample days, which fall past the six even weeks.

diminishing degree in recent years. All the even week dummy variables in both Panel A and B get a positive coefficient. Also all the coefficients are statistically significant at least at the 10% level, while a clear majority is significant at the 5% level. For example, column (1) which includes a bundled dummy variable for all of the even FOMC cycle weeks (i.e. weeks 0, 2, 4 and 6) shows that days on these even cycle weeks have produced on average 11.5 bps higher excess stock returns than days on odd numbered cycle weeks.

Our main interest lies in the subsequent columns which differentiate between week 0 and the other even cycle weeks, as high stock returns around FOMC meetings have been extensively documented by Lucca and Moench (2015) and others. Again, the results point to statistically higher returns on each of the even weeks. We also see that week 0 (13.7 bps) and, interestingly, week 6 (19.0 bps) show the strongest effect. By virtue of including the meeting days, week 0's significant contribution to the even week premium is easy to justify. However, week 6 is more perplexing at first glance. Referring again to Figure 1, we see that the number of observations that fall under week 6 are quite limited.

Overall, the results show evidence that the Federal Reserve has an impact on the stock markets not only around FOMC monetary policy meetings, but also in subsequent weeks. In addition, during the past 26 years the impact has been economically significant, as the cumulative return of the odd week days is negative. However, as we saw in Figure 3, this cycle effect decreases on the expanded sample. Now the coefficient for the even week dummy stands at only 9.2 bps, as is evident in column (4). This is, as expected, equal to the difference in average daily excess return (9.2 bps) that we calculated in Table 2. Also the coefficients in other columns decrease in the extended sample, as do their t-statistics. The dummy coefficients generally decrease by one-tenth to one-third, which is a substantial drop in magnitude. The even week premium has actually been very small or even non-existent during 2017-2019. Later in this study we show evidence that this decrease is indeed related to the lower uncertainty that the markets have recently witnessed.

Table III: Regressions of Daily U.S. Stock Returns on FOMC Cycle Dummies

This table presents results of regressions of daily excess U.S. stock returns on FOMC cycle dummies. Panel A replicates the results of Cieslak et al. (2019) and Panel B expands the sample to 2019. The dummies have the value of one for each day of the corresponding week. The definition of weeks in FOMC cycle time are: Week -1: Days -6 to -2; Week 0: Days -1 to 3; Week 1: Days 4 to 8; Week 2: Days 9 to 13; Week 3: Days 14 to 18; Week 4: Days 19 to 23; Week 5: Days 24 to 28; Week 6: Days 29 to 33. The left-hand-side variable is in percent, so (for example) 0.1 means 10 bps per day. Holidays are included with returns set to zero. We report t-statistics calculated with Newey-West (10 lags) standard errors robust to heteroscedasticity and autocorrelation. In the following tables we follow the methodology of Cieslak et al. (2019) in reporting standard errors, unless otherwise noted.

	Dependent variable: Excess Return on Stocks over T-Bills					
	Panel A: 1994-2016			**Panel B: 1994-2019**		
	(1)	(2)	(3)	(4)	(5)	(6)
Even week	0.115***			0.092***		
	$t = 3.844$			$t = 3.322$		
Week 0		0.137***	0.137***		0.098**	0.098**
		$t = 3.311$	$t = 3.310$		$t = 2.495$	$t = 2.495$
Week 2, 4, 6		0.105***			0.089***	
		$t = 3.094$			$t = 2.878$	
Week 2			0.087**			0.078**
			$t = 2.129$			$t = 2.112$
Week 4			0.112**			0.089**
			$t = 2.351$			$t = 2.064$
Week 6			0.190**			0.169**
			$t = 2.572$			$t = 2.457$
Constant	-0.023	-0.023	-0.023	-0.009	-0.009	-0.009
	$t = -1.156$	$t = -1.156$	$t = -1.156$	$t = -0.530$	$t = -0.530$	$t = -0.530$
Observations	6,000	6,000	6,000	6,782	6,782	6,782
R^2	0.002	0.003	0.003	0.002	0.002	0.002
Adjusted R^2	0.002	0.002	0.002	0.002	0.001	0.001
Note:						*p<0.1; **p<0.05; ***p<0.01

5.2 FOMC Cycle: Phenomenon Driven by Uncertainty

Having found evidence in support of hypothesis 1 that the even week premium exists, we continue by further investigating if the magnitude of the cycle has varied across different time periods and economic and market environments. Past studies (see e.g., Lucca & Moench, 2018; Kurov et al., 2019; Dor & Rosa, 2019) have documented a significant weakening of the pre-FOMC announcement drift in post-2011 samples, which expand the initial paper by Lucca and Moench (2015). Also other trading strategies and market "anomalies" have been known to weaken or completely disappear in out of sample analysis or following publication. Some of these anomalies include for example calendar effects such as weekend, holiday and time-of-the-month effects, and the January effect (Marquering, Nisser, & Valla, 2006). It is thus quite logical to suspect that a similar trend might be apparent with the FOMC cycle.

We test whether the magnitude of the even week premium has varied in our sample. We are especially interested in whether the effect has weakened after the financial crisis. Figure 4[3] presents the average even week premium by year since 1994. The analysis is similar to the one we conducted in Table II, the only difference being that each year constitutes its own sample. The median even week premium of the 26 years is 8.9 bps and the average is 9.2 bps, which is identical to the average that we calculated for the whole sample in Table II. However, the even week premium has varied heavily by year. In 18 out of the 26 years the premium has been positive. Years with the highest average premium are 2008 (49.1 bps), 2003 (38.0 bps) and 2000 (33.8 bps). 2008 was the year of the global financial crisis, whereas in 2000 the dot-com bubble burst. In 2003 United States began their invasion of Iraq, which could have caused uncertainty in the stock market in early 2003.

Eight years have seen a negative premium for days that occur during even weeks in FOMC cycle time. The years with the most negative even week premium are 2018 (-23.1 bps), 2001 (-14.0 bps) and 2006 (-11.6 bps). 2018 was marked by the end-year stock market slump among weakening economic data and rising interest rates. In 2001 the general direction of the market was still down, as valuations were recovering from the bubble levels. 2006 however, was a relatively stable year with the S&P500 appreciating 13%. In general, the negative premium years have not occurred simultaneously with the worst economic and financial shocks.

[3] Further yearly regression analysis is provided in Table XII and Table XIII in the appendix.

If we look at longer time periods we can see some changes in the general level of the premium. Out of the six years of 1990s that we have in our sample, five witnessed a positive premium. Average premium[4] was 11.8 bps. For the 2000s our sample includes all ten years, of which six had a positive premium. However, due to very high premiums in 2000, 2003 and 2008 the average remained at 11.9 bps. However, the 2010s witnessed a substantial reduction in the even week premium. Six of the ten years had a positive premium for an average of 4.8 bps. This is less than half of the premium during the previous two decades. In addition, years 2017-2019 all had a negative premium.

These results seem to tell a very different story to that of Cieslak et al. (2019) who claim that the effect is getting stronger. They found that the FOMC cycle had persisted after 2013, using 2014-2016 as an additional sample. As we can see in Figure 4, these three years happen to have a relatively high premium. Perhaps the timing of the data sample led the authors to conclude that the FOMC cycle has been getting strong recently, although based on our analysis the general level of the premium has been lower during the past decade than previously. Consequently, this is in line with the findings of Kurov et al. (2019), who claim that the reduced uncertainty post-2011 has contributed to the disappearance of the FOMC pre-announcement drift. This is one possible explanation, one which we will examine in depth later in this study. Other possible reasons could be increasing stock market efficiency (Tóth & Kertész, 2006) or changes in Federal Reserve's customs[5], work schedule or leadership[6].

As per hypothesis 2, we suspect that the potential cause for the yearly variation in even week premium is the level of uncertainty in the economy and the stock market. Negative developments in the economy and financial markets encourages the Fed to act. Similarly, as investors worry more about the future, they pay more attention to monetary policy. Uncertainty has previously been recognized as a key driver in other FOMC-related phenomena. Ai and Bansal (2018) argue that the risk premia associated with macroeconomic announcements is driven by resolution of uncertainty. Hu et al. (2019) and Boguth, Grégoire, and Martineau (2019) find evidence that heightened uncertainty before FOMC announcements, as measured by the option-implied volatility of the S&P500 (VIX), explains the FOMC pre-announcement drift. Martello and Ribeiro (2018) find in their working

[4]Calculated as the average of the annual premiums.
[5]In 2011, the Fed started holding press conferences after every other FOMC meeting.
[6]Since 1994 the Fed has had four different Chairs.

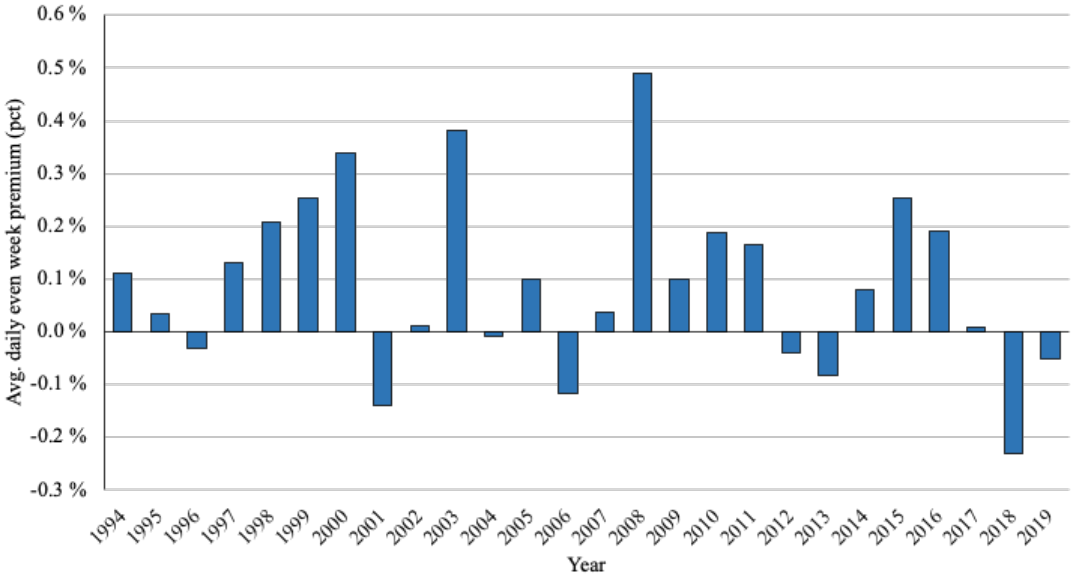

Figure 4: Even Week Premium by Year, 1994-2019

The figure presents the difference between daily excess stock market returns on odd and even weeks in FOMC cycle time in the respective year. The number of even and odd days varies by year. A negative value indicates that on average, days during odd weeks had higher excess returns.

paper that the FOMC pre-announcement drift is largely driven by meetings during distressed periods. They also suggest that the FOMC cycle might behave similarly. Kurov et al. (2019) explain the disappearance of the FOMC pre-announcement premium after 2015 with levels of VIX and TYVIX. In order to better understand this relationship between uncertainty and the FOMC cycle, we first look at the even week premium and the VIX level prevailing at the time. First, we sort all trading days between 1994-2019 into ten baskets. The sorting is conducted based on the value of VIX on the previous trading day. Basket 1 includes the days which had lowest values of VIX, whereas basket 10 includes days with the highest VIX value, and so forth. Each basket consists of 655 trading days[7], except baskets 7-10 which consist of 654 trading days each. We exclude weekends and holidays from our sample. Second, we sort all trading days in a single basket into "even week" and "odd week" days, as per the FOMC cycle. There are on average more odd week days, as we explained in section 5.1. On average, 53.6% of trading days in our sample occur during odd weeks. Next, we calculate the average return of odd and even days in a single basket. Finally, we calculate the even week premium as the difference between the two.

[7] A typical year has 252 trading days.

The even week premium is much stronger in magnitude at high levels of VIX. Figure 5 shows that the three baskets with the highest VIX (8, 9, and 10) account for around 93% of the whole even week premium, while the rest contribute very little in aggregate. The six lowest deciles contribute virtually zero to the premium. In fact, four of the ten deciles (1, 2, 5, 6) show a negative premium. This supports our hypothesis about uncertainty driving the even week premium.

The effect of VIX on the even week premium does not seem to be linear. Instead, there is seemingly a premium only when uncertainty is high, whereas at other times the premium is small or even negative. This helps to explain the large differences in Figure 4 between the different years. In some years, VIX has remained low for every trading day. If uncertainty really is the driver behind the premium, it is no wonder that the variation is so high.

Interestingly, basket 9 has a higher premium than basket 10, which includes the days with the highest values of VIX. One potential reason for this might be that during times of extreme turmoil, the FOMC tends to change the schedule of its meetings, and make decisions at unscheduled meetings. Our data sample does not include these unscheduled meetings. In 2008, year of the financial crisis, the Federal Open Market Committee held two unscheduled meetings at which it decided on emergency policies. Furthermore, the high premium of basket 4 does not seem to fit the thesis of a VIX driven even week premium. Basket 4 includes days with a previous day VIX-value between 14.26 and 15.81. It does not seem plausible that this particular level of VIX would have any special relationship with the premium. Thus, we rule out any FOMC related reasons and suggest that pure chance is the most likely cause.

Again, we confirm the statistical significance of our findings with a regression analysis. We run the regression of Equation (2) on different sub-samples based on the level of our volatility measures. We sort all trading days in 1994-2019 into categories based on the lagged value of VIX. We use four different categories: whole sample, bottom half, top half and the top quartile. The data excludes weekends and holidays and days for which a value of VIX could not be obtained. Thus, the sample includes 236 fewer days than in Table III. According to Hypothesis 2, we should see a statistically significant, positive relationship with VIX and the even week premium.

Table IV showcases results of Equation (2) run over multiple samples based on cut-offs set by the level of the previous days VIX index. The cut-off levels are shown in

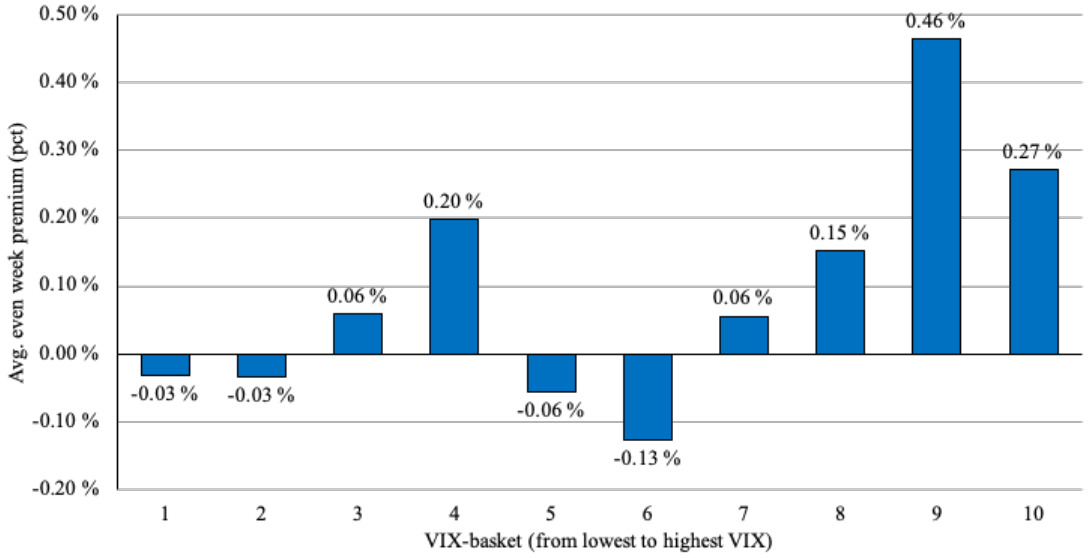

Figure 5: Even Week Premium by VIX-level

The figure represents the difference between daily excess stock market returns on even and odd weeks in FOMC cycle time with different levels of VIX. The numbers next to the bars represent values on the vertical axis. Each basket contains 1/10 of trading days in 1994-2019, with basket 1 consisting of the days with the lowest value of VIX and basket 10 of the days with the highest value.

Table VI. Results of Table IV tell a compelling story in favor of uncertainty playing a significant role in mediating the existence of FOMC cycle even week premium. Coefficients for the even week dummies for the bottom half of the sample are insignificant and, when compared to the full sample, considerably smaller in magnitude at 3.3 bps and 3.4 bps for week 0 and the other even weeks, respectively. For the top half of the sample the coefficients are almost double the magnitude of the full sample. Week 0 days earn on average a 17.4 bps premium. Days on weeks 2, 4, and 6 earn a premium of 16.1 bps in comparison to their odd week counterparts. The coefficients are also significant at the 5% and 1% levels, respectively. The premium is even more economically significant for the top quartile of the sample, in which the even week premium is 33.6 bps for week 0 and 31.6 bps in other even weeks. The coefficients more than triple when compared to the full sample, and almost double when compared to the top half. Both coefficients are also now significant at the 1% level. The constant term of the top quartile sample is negative (-10.8 bps) and significant at the 10% level, which means that returns on odd days during high volatility are particularly low. This means that holding risky assets during high uncertainty odd weeks is extremely detrimental to portfolio returns. In contrast, during low uncertainty the estimated odd week daily return is positive

at 1.3 bps. Based on the coefficients, high-uncertainty days seem to explain a large share of the even week premium.

We are also interested in the difference between high and low VIX premiums, and thus calculate the difference between top quartile and bottom half estimates. We also calculate the z-score[8] for the difference between the top 25% and bottom 50% coefficient. The difference is 30.4 bps for week 0 and 28.1 bps for weeks 2, 4 and 6. Week 0 is significant at the 5% level and the bundled coefficient is significant at the 1% level. The high VIX days really are special from a FOMC cycle perspective. Overall, these results support hypothesis 2.

Table IV: Impact of Uncertainty: Regressions of Daily U.S. Stock Returns on FOMC Cycle Dummies over VIX Levels, 1994-2019

This table presents regressions of daily excess U.S. stock returns on FOMC cycle dummies with samples sorted by level of the preceding days VIX. Days with no value for VIX are excluded (holidays etc.). The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps per day impact on excess returns. We report t-statistics calculated with standard errors robust to heteroskedasticity.

	Excess Return on Stocks over T-Bills				
			$VIX_{(t-1)}$ level:		
	Full sample	Bottom 50%	Top 50%	Top 25%	Top 25% - Bottom 50%
Week 0	0.104^{**}	0.033	0.174^{**}	0.336^{**}	0.304^{**}
	$t = 2.515$	$t = 0.973$	$t = 2.328$	$t = 2.529$	$z = 2.213$
Week 2, 4, 6	0.098^{***}	0.034	0.161^{***}	0.316^{***}	0.281^{***}
	$t = 3.132$	$t = 1.386$	$t = 2.819$	$t = 3.170$	$z = 2.742$
Constant	-0.014	0.013	-0.041	-0.108^{*}	
	$t = -0.753$	$t = 0.824$	$t = -1.225$	$t = -1.888$	
Observations	6,546	3,270	3,276	1,640	
R^2	0.002	0.001	0.003	0.008	
Adjusted R^2	0.002	0.0001	0.003	0.007	
Note:					*p<0.1; **p<0.05; ***p<0.01

To further decipher the origin of the FOMC cycle even week premium, we replicate the analysis of Table IV with TYVIX, which is the 10-year U.S. Treasury Note Volatility Index and a market-based proxy for monetary policy uncertainty (Kurov et al., 2019). The results are again in line with the hypothesis 2 that uncertainty is a key driver for the FOMC cycle effect. Week 0 and week 2, 4 & 6 dummies get positive and statistically significant coefficients in the full sample regression as

[8]We perform the Z-test based on methodology detailed by Clogg, Petkova, and Haritou (1995) and cited by Paternoster, Brame, Mazerolle, and Piquero (1998). The significance is determined based on a two-tailed test.

well as in both high uncertainty samples. The coefficients also grow significantly larger as uncertainty grows. Among top 25% uncertainty days, week 0 (week 2, 4, 6) delivers extra 39.3 bps (24.7 bps), whereas for the full sample the effect is 9.2 bps (8.8 bps). Also the differences between coefficients of high and low uncertainty samples are significant at the 1% and 5% level, respectively.

Table V: Impact of Monetary Policy Uncertainty: Regressions of Daily U.S. Stock Returns on FOMC Cycle Dummies over TYVIX Levels, 2003-2019

This table presents regressions of daily excess U.S. stock returns on FOMC cycle dummies with samples sorted by level of the preceding days TYVIX. Days with no value for TYVIX are excluded (holidays etc.). The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps per day impact on excess returns. We report t-statistics calculated with standard errors robust to heteroskedasticity.

	Excess Return on Stocks over T-Bills				
			$\text{TYVIX}_{(t-1)}$ level:		
	Full sample	Bottom 50%	Top 50%	Top 25%	Top 25% - Bottom 50%
Week 0	0.092^{*}	-0.005	0.191^{**}	0.393^{**}	0.399^{**}
	$t = 1.734$	$t = -0.109$	$t = 2.016$	$t = 2.301$	$z = 2.240$
Week 2, 4, 6	0.088^{**}	0.012	0.163^{**}	0.247^{**}	0.235^{*}
	$t = 2.323$	$t = 0.333$	$t = 2.457$	$t = 2.128$	$z = 1.933$
Constant	-0.006	0.027	-0.039	-0.099	
	$t = -0.276$	$t = 1.280$	$t = -0.990$	$t = -1.472$	
Observations	4,268	2,125	2,143	1,075	
R^2	0.002	0.0001	0.004	0.008	
Adjusted R^2	0.001	-0.001	0.003	0.006	
Note:					*p<0.1; **p<0.05; ***p<0.01

Table VI: Sample Cut-Offs

This table presents the cut-off values for VIX and TYVIX that are used for categorizing samples in Table IV and Table V. Observations, which fall on the median cut-off line are included in the latter category.

	Min	25%	50%	75%	Max
VIX	9.14	13.55	17.55	22.87	80.86
$TYVIX$	3.16	4.69	5.59	7.46	14.72

5.2.1 *Establishing Causality Between VIX and the FOMC Cycle*

We argue the following: if one assumes that higher uncertainty causes a larger even week premium, and that this premium is caused by information flowing from the Fed to market participants, it means at least one of three things. First, investors could pay more attention to news arriving from the Fed during times of uncertainty. Due to increased attention, this would then lead to a faster and larger price reaction. Second, the information that flows from the Fed during times of uncertainty is more interesting than at other times. Third, there could simply be more information. We look at all these three hypotheses. Stein (1989) and Blinder, Goodhart, Wyplosz, Hildebrand, and Lipton (2001) argue that investor attention is a critical component for the transmission of central banks' monetary policy. Andrei and Hasler (2015) find that investor attention to the economy, as measured by Google search volume, has predictive power about the market risk premium. They further claim that low attention leads to slower reaction to news, whereas higher attention is followed by a faster reaction. Da, Engelberg, and Gao (2011) and Da, Engelberg, and Gao (2015) use Google search volume as a proxy for investor attention. They argue that search-based measures reveal people's true attitudes, whereas survey-based alternatives have many biases. Based on these works, we also use a Google Trends based measure for investor attention. As per hypothesis 3a, we expect higher uncertainty to lead to a higher interest in the Fed among investors.

In Figure 6 we have plotted the relative number of Google searches made in the New York area for "Federal Reserve" of each month with the average level of VIX during that month. A Google Trends value of 100 is given to the month when the search term was most popular, and is twice as high as a value of 50. Further regression analysis can be found in Table XIV in the appendix. From the graph we can see that there is a positive correlation between the interest in Fed and VIX. In other words, high uncertainty is followed by increased attention in the Fed. The correlation coefficient between the two is 30.6%. We believe that this is logical, since at times of heightened uncertainty, investors might look at the central bank for accommodative measures. A major limitation of this analysis is the relatively low frequency of the Google Trends value. A single month could witness both periods of high and low interest or uncertainty. Using more granular data would thus increase the accuracy of our analysis. Additionally, the Google trends value is relative to overall search activity, which might cause a downward trend for the

index [9], which introduces a bias to our results.

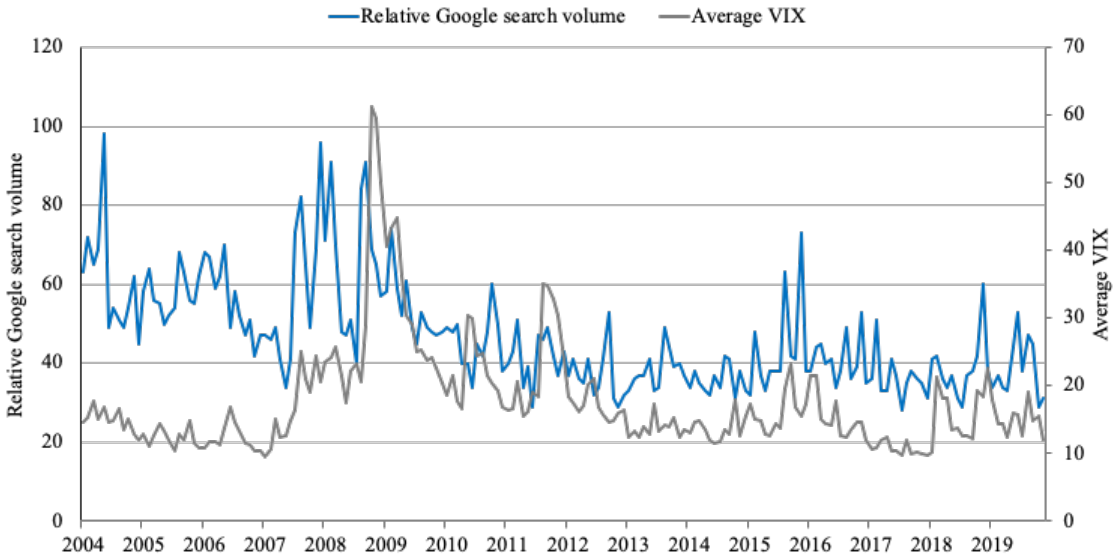

Figure 6: "Federal Reserve" Google Search Volume and Average VIX
The left vertical axis represents the monthly relative popularity of the search term "Federal Reserve" in the New York Area. A value of 100 represents the month with the highest relative popularity. The right vertical axis represents the average value of VIX in the corresponding month. In general, there is a downward bias in relative Google search volumes as new search terms are constantly introduced.

We also look at how the "significance" of the information that is leaking from the Fed to the markets varies. A key policy tool for the Fed is the federal funds rate. Fed doesn't publicly disclose in advance whether it is going to change this rate. However, if the unusually high even week returns are due to information that suggests unusually strong accommodative policy changes, this should be seen as a propensity to lower rates more frequently and by a stronger magnitude at times of high uncertainty. Based on our analysis, this seems to be the case. Figure 7 shows the meetings when Fed made a change in the policy rate during 1994-2019. There are 72 such meetings in total. The FOMC tends to make target rate changes in multiples of 25 bps. From Figure 7 it can be seen that the Fed tends to reduce rather than increase the policy rate after periods of high uncertainty. In contrast, at times of extreme calm the average change in target rate is positive. There is a clear linear relationship between uncertainty and target rate change. Meetings in the highest quartile, as measured by VIX, have resulted in a target rate cut of 34.7 bps on average. The average target rate change for the other meetings has been +22.2

[9] https://support.google.com/trends/answer/4365533?hl=en

bps for lowest VIX meetings in quartile 1, +18.1 bps for quartile 2 and -12.5 bps for quartile 3. For further analysis, see Table XV in the appendix. These results are in line with hypothesis 3b.

We know from Cieslak et al. (2019) that the Fed has incentives to conduct informal communication with the markets. It would be only logical that the more radical changes the Fed is planning, the more there is communication. This would explain why times of extreme uncertainty, which have seen the Fed use its full arsenal of policy tools, witness the highest even week premium. It is also noteworthy that the policy moves during uncertain times are by default accomodative in nature. Increased communication at times of uncertainty is also in line with a Fed that does not want to surprise markets, as suggested by e.g. Stein and Sunderam (2018).

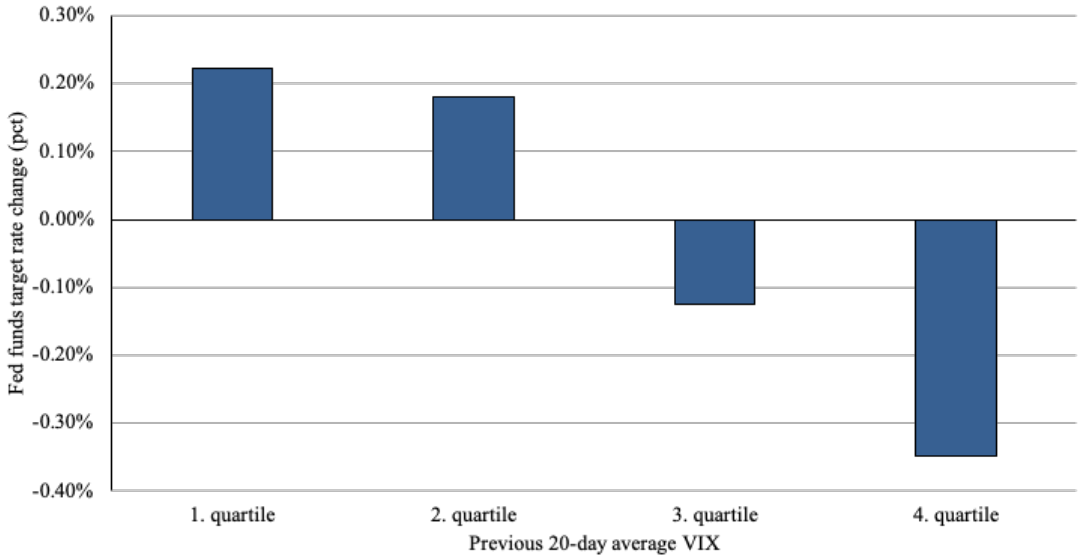

Figure 7: Fed Funds Target Rate Changes and Average VIX, 1994-2019
The figure represents the average Fed Funds target rate change after different levels of VIX. The data consists of 72 meetings with rate changes. The category labels represents the average level of VIX prior to the monetary policy meeting in which the rate change is decided. Meetings are allocated to quartiles depending on the prior 20-day average VIX level. Quartile 1 includes the meetings with lowest prior VIX level, while quartile 4 includes the meetings with the highest prior VIX level.

Finally, we look at the supply of information flowing from the Fed to the markets at various times. Although we cannot quantify the amount of informal information that is leaking from the Fed to the market, we argue that the number of press releases is a reasonable proxy for the supply of information. After all, the number

of press releases should be driven by the amount of information that needs to be shared to the general public. We gather the historical press releases manually from Federal Reserve's web page. In total, we count 5,267 press releases published during the 6,262 days in our sample, which is around 0.84 releases per day. We estimate a regression model where the value of VIX on day t-1 explains the number of press releases in the future. We use VIX to explain press releases during the next day, week, two weeks and four weeks.

In Table VII we show the results of the regression. We find that VIX is a decent predictor for the number of future Fed press releases. The value of VIX has a statistically significant, positive effect on the number of press releases during the following day, week, two weeks and four weeks. All coefficients are significant at the 1% level. The magnitude of the effect is also quite significant. A 20 point increase in VIX would on average increase the number of press releases during the next four weeks by around five. This is quite a dramatic increase and in our opinion reflects how the amount of information flowing from the Fed to the general public tends to increase during times of uncertainty. This is in line with hypothesis 3c.

Table VII: Regression of Number of Fed Press Releases on VIX, 1996-2019

This table presents the results of regressing the number of Fed press releases on the preceding day's VIX. The time period for the number of releases increases from one day to four weeks over the columns. We report t-statistics calculated with Newey-West (10 lags) standard errors robust to heteroscedasticity and autocorrelation.

	Dependent Variable: Number of Fed Press Releases			
	Time period for number of releases:			
	One day	One week	Two weeks	Four weeks
VIX_{t-1}	0.014^{***}	0.069^{***}	0.139^{***}	0.268^{***}
	$t = 5.138$	$t = 3.905$	$t = 2.892$	$t = 3.130$
Constant	0.571^{***}	2.839^{***}	5.664^{***}	11.498^{***}
	$t = 11.248$	$t = 8.512$	$t = 6.559$	$t = 7.644$
Observations	6,042	6,042	6,042	6,042
R^2	0.011	0.043	0.066	0.083
Adjusted R^2	0.011	0.043	0.066	0.083
Note:				*p<0.1; **p<0.05; ***p<0.01

Together, these results help to explain the link between uncertainty and the magnitude of the even week premium. The premium is driven by information which flows from the Fed to the markets during even weeks. During times of uncertainty,

investors are more interested in Fed-related information. Simultaneously, there is an increased amount of information available. Finally, the information is more likely to be supportive of stock prices. Together these forces explain why we argue that the even week premium is predominantly a phenomenon driven by market uncertainty.

5.3 Discussion of the Results

Our results have many implications for investors and the society at large. First, investors might need to reconsider their strategies, especially during uncertain periods. They need to realize that conventional factors might lose their importance during periods of high uncertainty and that investment strategies based on these factors might not work as planned. The fact that informal information from the central bank can help one to achieve extraordinary returns raises questions about fairness. Investors who do not have strong relationships with the Fed might find themselves outside the inner circle and question whether the stock market really is a level playing field. We believe that retail and foreign investors are especially at risk. This might have negative effects on the functioning of the stock market.

From a societal standpoint, the magnitude of the FOMC cycle seems baffling. Central bankers need to realize the sizeable role that investors are readily willing to hand them at times of uncertainty. Furthermore, they need to take it into account when drafting and communicating their future policies. Lastly, if investors focus more on the Fed during uncertain times, they might pay less attention to fundamentals, such as the state of the economy or company sales growth, profitability and leverage. This could have undesirable consequences for the pricing of different assets. After all, how unlimited is the Fed's impact on the real economy? For example, the COVID-19 pandemic might prove to be an obstacle to economic growth that the Fed cannot remove on its own (see e.g., Lahart, 2020). We fear that excessive fixation on the Fed might in the long run cause stock market bubbles and consequent crashes, which have damaging effects on the society.

5.4 Robustness Checks

5.4.1 *Controlling for Other Events*

In order to determine that the uncertainty-driven biweekly return pattern is indeed caused by the FOMC cycle, we need to rule out the influence of other news releases and calendar events. The FOMC meeting schedule varies over the years, meaning

it is less likely that the days systematically overlap with other calendar events (Cieslak et al., 2019). Cieslak et al. (2019) also show that the biweekly return pattern is not explained by e.g. macroeconomic and earnings announcement days, reserve maintenance period days nor by dates on which other Fed releases occur. In addition to including controls inspired by the past authors, we also introduce new variables that have surfaced in years since the publication of the initial study. Namely, we account for cycles followed by a press conference and for the liquidity induced cycle caused by the U.S. T+3 settlement. It is worthwhile to control for these events and other important days to see how their importance develops as we look at samples across different levels of uncertainty.

In Table VIII, we replicate the regression of Table IV with added controls for monthly liquidity induced cycle (*Dash*), other macro announcements, company earnings releases, cycles with press conferences and for beige book release dates. These added controls do not significantly diminish the uncertainty-driven FOMC even week returns. The difference between the top VIX quartile and the bottom half of the sample stands at 29.1 bps and 27.6 bps for the days of the highest VIX quartile for weeks 0 and weeks 2, 4, 6 respectively. Likewise, the results are significant at the 5% and 1% levels. The differences have decreased only slightly from their equivalents presented in Table IV (Week 0: 30.4 bps and Week 2, 4, 6: 28.1 bps).

Below we go further into the rationale and methodology behind each of the control variables.

(a) Controlling for the Dash for Cash Effect

Etula, Rinne, Suominen, and Vaittinen (2020) find that monthly recurring payments such as pensions and dividends, that are concentrated around the turn of the month, cause economy participants to "Dash for Cash". Because of the U.S. T+3 settlement, institutions need to sell assets already couple of days prior if they wish to hold the cash at the turn of the month. Thus, asset sales are concentrated on a few calendar days, which drives down the prices. After the selling pressure, prices rise substantially for multiple days. Furthermore, the authors provide evidence that cost of debt and equity is moves in a similar pattern during this window at the end of each month. These days in turn may overlap with the FOMC cycle weeks.

Based on this, we construct a dummy variable *Dash*, which takes the value of

Table VIII: Controlling for Other Events: Regressions of Daily U.S. Stock Returns on FOMC Cycle Dummies over VIX Levels, 1994-2019

This table presents the results of regressing U.S. excess stock returns on FOMC even week dummies over various categories based on the preceding days VIX, with controls added for the monthly liquidity induced cycle (*Dash*), macro announcements listed in Table I, company earnings announcements, meetings with press conference and for Beige Book release dates. Days with no value for VIX are excluded (holidays etc.). The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps per day impact on excess returns. We report t-statistics calculated with standard errors robust to heteroskedasticity.

	Excess Return on Stocks over T-Bills				
		$VIX_{(t-1)}$ level:			
	Full sample	Bottom 50%	Top 50%	Top 25%	Top 25% - Bottom 50%
Week 0	0.093**	0.032	0.156**	0.323**	0.291**
	$t = 2.231$	$t = 0.953$	$t = 2.071$	$t = 2.419$	$z = 2.114$
Week 2, 4, 6	0.092***	0.028	0.149***	0.304***	0.276***
	$t = 2.952$	$t = 1.104$	$t = 2.641$	$t = 3.067$	$z = 2.698$
Dash	0.063*	0.032	0.101	0.150	0.118
	$t = 1.798$	$t = 1.080$	$t = 1.575$	$t = 1.387$	$z = 1.052$
Macro announcements	0.055**	0.043**	0.065	0.055	0.012
	$t = 2.481$	$t = 2.330$	$t = 1.561$	$t = 0.767$	$z = 0.162$
Earnings announcements	0.001	−0.001	0.004	0.011*	0.012**
	$t = 0.725$	$t = -0.949$	$t = 1.329$	$t = 1.955$	$z = 2.096$
Press conference	0.051*	0.017	0.139*	0.111	0.094
	$t = 1.755$	$t = 0.677$	$t = 1.865$	$t = 0.616$	$z = 0.517$
Beige Book	0.069	0.085	0.057	0.247	0.162
	$t = 0.823$	$t = 1.296$	$t = 0.375$	$t = 0.909$	$z = 0.580$
Constant	−0.060***	−0.005	−0.117***	−0.230***	
	$t = -2.605$	$t = -0.263$	$t = -2.886$	$t = -3.275$	
Observations	6,546	3,270	3,276	1,640	
R^2	0.005	0.004	0.007	0.014	
Adjusted R^2	0.004	0.002	0.005	0.009	
Note:					*p<0.1; **p<0.05; ***p<0.01

one for the three days that precede and follow the last trading day of each month. Indeed, the Dash days seem to yield higher returns as the coefficients for the variable range from 3.2 bps up to 15 bps as we move towards the higher VIX categories.

However, the coefficients are statistically significant only for the full sample (6.3 bps) at the 10% level, leaving the biweekly dummies intact.

(b) Controlling for Non-Fed Announcements

Consequently, we control for U.S. macroeconomic announcements and company earnings releases. First, we collect the macroeconomic announcement dates which

according to Ernst et al. (2019) contribute most to the equity premium. These announcements are listed in Table I. We then form a control variable, *Macro announcements*, which takes the number of macro announcements on a given date as its value. Again, the results in Table VIII show that the announcement dates do influence the daily excess stock returns. Effects of the *Macro announcements* variable on excess stock returns range from 4.3 bps to 6.5 bps per announcement. The coefficients are also statistically significant at the 5% and 1% level for the full and bottom 50% sample.

Similarly, we collect the daily number of quarterly earnings reports by S&P 500 firms for each day of our 1994-2019 sample. The dates are obtained from Worldscope database using Refinitiv Datastream. The number of daily earnings releases range from 0 to 62, with the median number being two. We then use these daily release numbers as a control variable in our model. The *Earnings announcements* variable's impact on excess stock returns range from -0.1 bps per release up to 1.1 bps per release over the VIX samples. This translates to an impact of 11 bps on the equity premium on a day with ten earnings releases and VIX level at it's top quartile. The difference between the top 25% and bottom 50% is 12 bps and its significant at the 5% level. This indicates that the earnings releases could be of more interest during times of high uncertainty and also provide more positive surprises during these periods. Bonsall IV, Green, and Muller III (2020) find evidence for this in their study. They find that uncertainty increases media coverage for earnings announcements. It also leads to increased trading and price timeliness as well as reduced information asymmetry.

(c) Controlling for Press Conference and Beige Book

Lucca and Moench (2018) find that during their updated sample covering the period between April 2011 and June 2018, the pre-FOMC announcement drift is driven by meetings that are followed by a press conference given by the Chairman of the FOMC. Following these meetings, Fed also releases a summary of its members' economic projections. On average, every other FOMC meeting includes these two additional information sources. Our rationale behind this *Press conference* variable is that these press conference meetings include more information that might leak out already before the actual meeting. Based on this insight, we form a dummy variable that has the value of one for each day of the cycle that precedes a meeting with a press conference. Results of Table VIII show that the variable does have a positive coefficient that peaks at 13.9 bps (significant at the 10% level) for the

top 50% sample. The variable fails to reach significance for the other subsamples, though.

The Beige Book, which is a summary of commentary on current economic conditions by the twelve Federal Reserve Districts, is published eight times a year. The book is released two weeks *prior* to each scheduled FOMC meeting (Cieslak et al., 2019). As such, it could explain some of the even week premium earned on week 4 of the cycle. Hence, we create a dummy variable that has the value of one on days which include a Beige Book release. Table VIII shows that the coefficients for the *Beige Book* variable, though positive, are insignificant throughout the different samples. Thus, they do not meaningfully affect excess stock returns.

5.4.2 *Accounting for Fed Put*

Cieslak et al. (2019) argue that over half of the proposed FOMC even week premium can be explained by what they refer to as "Fed put". In essence, this term refers to the larger than expected monetary policy accommodations that follow stock market declines. They show that this put shaped pattern is evident both in stock returns and federal funds target changes. Cieslak and Vissing-Jorgensen (2020) later elaborate on the theory with a textual analysis on FOMC minutes and transcripts. The results of this further analysis indicate that it is indeed the stock market that drives Fed policy more so than standard macroeconomic news.

Thus, we regress U.S. excess stock returns on FOMC cycle dummies once more with an added dummy variable, *Put*. Put takes the value of one for days, which based on the past trading week's return belong to the poorest performing quintile. We again run this analysis on subsamples categorized by different levels of lagged VIX. We also include the interaction term between the even week dummies and the Put dummy to asses the proposed influence of the phenomenon on the cycle.

The results in Table IX provide some support for the results of Cieslak et al. (2019). The coefficient for interaction between Week 2, 4 , 6 and the Put dummy is 18.3 bps (significant at the 5% level). This suggests that the even week premium is stronger for week 2, 4, 6 days that are preceded by poor stock returns. However, for week 0 days, the impact of past stock returns seems to be much more modest, as the interaction term does not reach statistical significance in any sample. The interaction terms do not vary considerably over the different subsamples, which indicates that the "Fed put" effect is not as strongly correlated with the level of uncertainty in the economy. The differences for the week 0 and week 2, 4, 6

dummies stand at 33.5 bps and 19.8 bps, respectively, which demonstrates the role that uncertainty plays in driving the FOMC even week premium. These differences are significant at the 5% and 10% level, respectively.

Table IX: Accounting for Fed Put: Regressions of Daily U.S. Stock Returns on FOMC Cycle Dummies over VIX Levels, 1994-2019

This table presents the results of regressing U.S. excess stock returns on FOMC even week dummies and their interaction with a dummy for lagged returns (*Put*). Put has the value of one for days, which belong to the poorest performing quintile based on past trading week's returns. The regression is ran over four samples categorized by the preceding days VIX. The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps per day impact on excess returns. We report t-statistics calculated with standard errors robust to heteroskedasticity.

	Excess Return on Stocks over T-Bills				
		$VIX_{(t-1)}$ level:			
	Full sample	Bottom 50%	Top 50%	Top 25%	Top 25% - Bottom 50%
Week 0	0.087^{**}	0.028	0.166^{**}	0.363^{**}	0.335^{**}
	$t = 2.223$	$t = 0.825$	$t = 2.102$	$t = 2.318$	$z = 2.091$
Week 2, 4, 6	0.059^{**}	0.020	0.112^{*}	0.218^{*}	0.198^{*}
	$t = 1.998$	$t = 0.805$	$t = 1.846$	$t = 1.862$	$z = 1.654$
Put	0.004	-0.006	0.038	0.065	
	$t = 0.073$	$t = -0.079$	$t = 0.479$	$t = 0.536$	
Week 0 x Put	0.092	0.079	0.029	-0.064	
	$t = 0.629$	$t = 0.406$	$t = 0.154$	$t = -0.228$	
Week 2, 4, 6 x Put	0.183^{*}	0.183	0.140	0.222	
	$t = 1.766$	$t = 1.590$	$t = 1.039$	$t = 1.063$	
Constant	-0.015	0.013	-0.053	-0.135^{**}	
	$t = -0.844$	$t = 0.846$	$t = -1.509$	$t = -2.088$	
Observations	6,546	3,270	3,276	1,640	
R^2	0.004	0.002	0.005	0.010	
Adjusted R^2	0.003	0.001	0.003	0.007	
Note:			*p<0.1; **p<0.05; ***p<0.01		

5.4.3 *Extented Sample Analysis*

As an out of sample analysis, we study the even week premium in the first half of 2020. Periods of high uncertainty are relatively rare in our base sample covering years 1994 to 2019. Thus, we believe that the global COVID-19 virus pandemic of 2020 and resulting turmoil in the stock markets provides us a valuable avenue for extra analysis. Moreover, the vigorous monetary policy response of central banks, including the Fed, makes the time period ideal for developing further insight about the even week premium.

In Figure 8, we can see the cumulative excess U.S. stock market return in the first six months of 2020. The shaded areas mark even weeks in FOMC cycle time. We find that on average even week days had lower excess returns than odd weeks. The average daily excess return in 2020 is -36.9 bps for even weeks whereas for odd weeks it is 24.3 bps. There are no signs of higher returns during even weeks in 2020, quite the contrary. This, despite the fact that the VIX index is very high for much of the first half of 2020.

At first glance, these results do not support the thesis of a biweekly pattern. However, we believe that certain factors are affecting the results. One possible explanation is non-scheduled monetary policy meetings. As can be seen from the graph, in March there is a long period without any even weeks. After COVID-19 outbreak the FOMC cancelled its scheduled March meeting and instead held a number of unscheduled emergency meetings, where they decided on policy moves. For example, on March 15th the FOMC cut the Fed Funds target rate by a full percentage point. The meeting was unscheduled. However, in line with the methodology of Cieslak et al. (2019), we do not include unscheduled meetings in our data. Furthermore, in the first half of 2020 the largest recovery in the stock market takes place during a period when all scheduled meetings are canceled. Thus, it is no wonder that even weeks deliver lower returns on average.

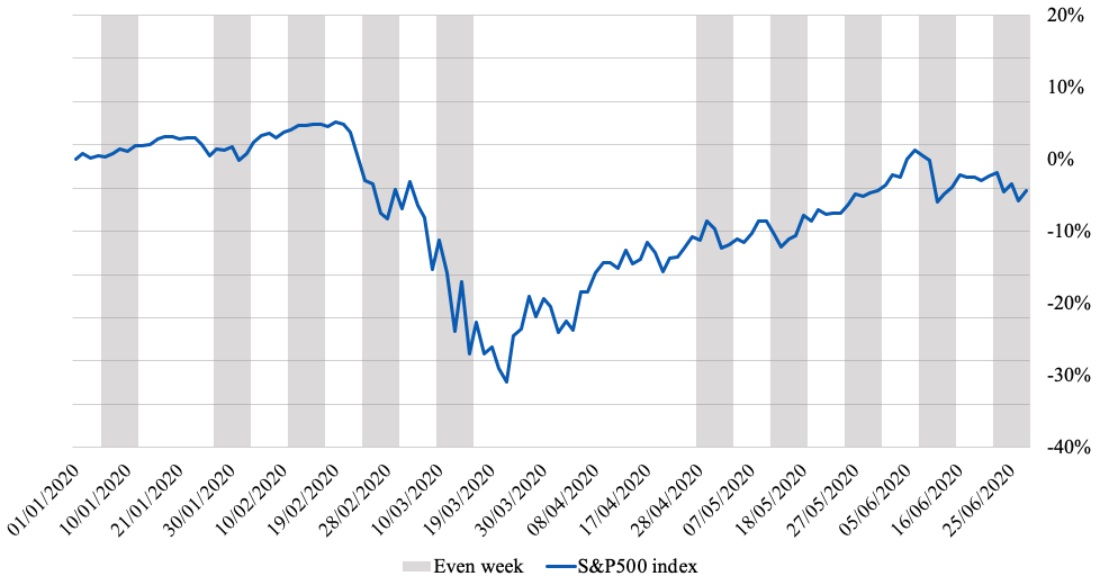

Figure 8: U.S. Excess Stock Market Returns & FOMC Cycle, 2020

The figure represents the cumulative return of the S&P500 in January-June, 2020. The shaded areas mark even weeks in FOMC cycle time. Weekends and holidays are excluded from the figure.

6. European Evidence

While the U.S and global stock markets have been documented to enjoy high returns in the days around the FOMC meeting, no similar effect has been found for other central banks around the world and their respective domestic markets (Brusa et al., 2020). Likewise, the FOMC cycle and its even week premium are special in the sense that literature provides limited evidence of similar studies conducted in other markets.

However, Ulrich et al. (2017) provide evidence of economically and statistically large 24-hour ECB pre-announcement returns being present in European equity markets during the years 2010 to 2015. Europe was dealing with the sovereign debt crisis during these years and there were fears of the Union breaking down. This motivates us to explore whether a cyclical equity premium could be present for the ECB and the European stock market, especially during times of elevated uncertainty.

We begin our analysis by constructing a cycle in the fashion of Cieslak et al. (2019) based on the ECB governing councils' monetary policy meeting schedule. We then replicate the analysis of Figure 3 and plot the average 5-day excess returns during the ECB in Figure 9. The time period starts from year 2002, right after the once a month meeting schedule was adopted for the governing council's monetary policy meetings (which was later adjusted to the current 6-week cycle in 2015).

As expected, the ECB graph differs drastically from its FOMC counterpart. No clear biweekly cycle is evident. In fact, the returns seem to be high during week -1 prior to the meeting compared to those of week 0. The peaks in returns seem to land on the periods following days -6, 14, 22 and 28 in the ECB cycle.

Due to the shorter cycle time which persisted for most of the time period covered, the sample size drops drastically at week 3 of the cycle, as is evident in Figure 2. Nonetheless, the graph in Figure 9 showcases that the days surrounding the ECB monetary policy meeting provoke a much different reaction in the stock market as opposed to those of the FOMC.

We then look at how uncertainty may impact the ECB-cycle. We therefore replicate the analysis of Table IV for Europe using the EURO STOXX 50 volatility index (VSTOXX) as our proxy for uncertainty while the EURO STOXX 600 index acts as our base European equity return. The results of this analysis are presented in

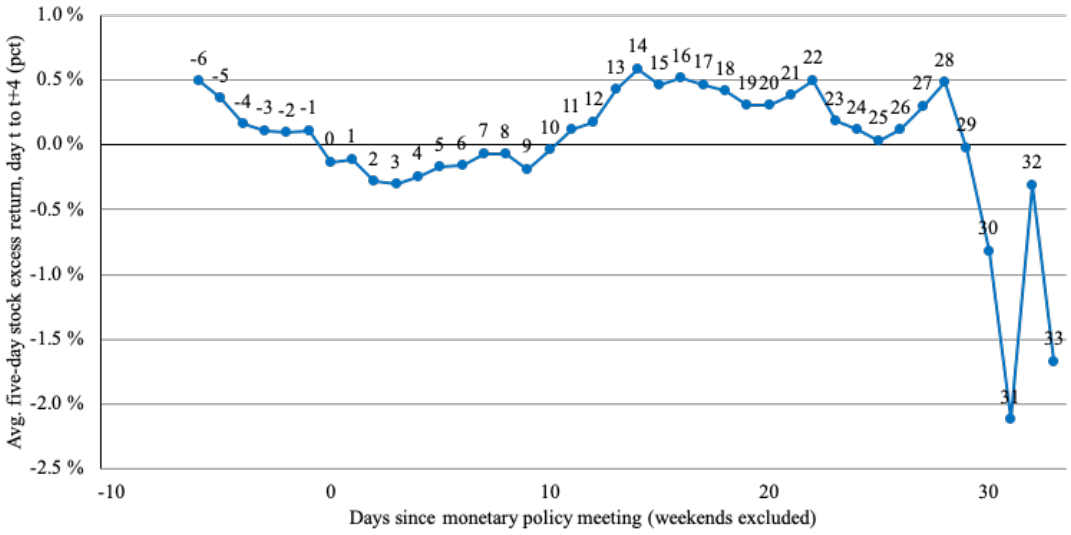

Figure 9: Avg. 5-day Excess Return During the ECB-Cycle, 2002-2019
The plot is based on data covering 195 ECB cycles. The numbers along the line indicate the value on the horizontal axis. The five-day (forward) returns computed for any of the week -1 days (-6 through -1) of the ECB cycle are not used in the right part of the graph. Thus, average returns for days late in the cycle consist of fewer observations.

Table X.

Again, the results of Table X differ vastly from their U.S. equivalent. The coefficients for the even week dummies are statistically insignificant throughout the board and actually have a negative a sign for majority of the time. Although the coefficient for week 0 dummy is the most positive in the highest uncertainty quartile at 3.3 bps, it is still nowhere near significant. Simultaneously, the coefficient on weeks 2, 4, 6 is -13.5 bps and statistically insignificant as well.

Brusa et al. (2020) and Cieslak et al. (2019) document that the FOMC meeting premium and the FOMC even week cycle returns are present in international stock markets as well. Inspired by these findings, we regress daily excess European stock returns on FOMC even week dummies and run this analysis over the 2002-2019 sample period, sorted by level of the preceding days VIX. We use day $t + 1$ returns as our left-hand side variable as the impacts of the U.S. news will likely transfer to the European market only on the following day due to the time difference.

The results of Table XI are in line with the past findings. The FOMC biweekly cycle seems to be present in the European stock market but it is driven by the periods of high uncertainty. The difference between the daily returns of top quartile and bottom half are 38.6 bps and 29.8 bps for the week 0 and week 2, 4, 6 returns,

Table X: Regressions of Daily European Stock Returns on ECB Monetary Policy Cycle Dummies over VSTOXX Levels, 2002-2019

This table presents regressions of daily excess European stock returns on ECB monetary policy cycle dummies with samples sorted by level of the preceding days VSTOXX. Days with no value for VSTOXX are excluded (holidays etc.). The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps per day impact on excess returns. We report t-statistics calculated with standard errors robust to heteroskedasticity.

	Dependent Variable: Excess Return on Stocks Over Euro Area Risk-Free Rate			
		$\text{VSTOXX}_{(t-1)}$ level:		
	Full sample	Bottom 50%	Top 50%	Top 25%
Week 0	−0.010	0.016	−0.035	0.033
	$t = -0.204$	$t = 0.450$	$t = -0.409$	$t = 0.217$
Week 2, 4, 6	−0.056	−0.005	−0.109	−0.135
	$t = -1.348$	$t = -0.136$	$t = -1.413$	$t = -1.007$
Constant	0.035	0.013	0.056	0.087
	$t = 1.522$	$t = 0.675$	$t = 1.365$	$t = 1.216$
Observations	4,580	2,290	2,290	1,145
R^2	0.0004	0.0001	0.001	0.001
Adjusted R^2	-0.00004	-0.001	-0.00001	-0.001
Note:				*p<0.1; **p<0.05; ***p<0.01

Table XI: Regressions of Daily European Stock Returns on FOMC Cycle Dummies over VIX Levels, 2002-2019

This table presents regressions of daily excess European stock returns on FOMC cycle dummies with samples sorted by level of the preceding days VIX. The returns are $t + 1$ to account for the time difference. Days with no value for VIX are excluded (holidays etc.). The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps per day impact on excess returns.

	Dependent Variable: Excess Return on Stocks over Euro Area Risk-Free Rate				
		$\text{VIX}_{(t-1)}$ level:			
	Full sample	Bottom 50%	Top 50%	Top 25%	Top 25% - Bottom 50%
Week 0	0.081	0.025	0.138	0.410**	0.386**
	$t = 1.601$	$t = 0.598$	$t = 1.502$	$t = 2.547$	$z = 2.317$
Week 2, 4, 6	0.059	−0.038	0.154**	0.260**	0.298**
	$t = 1.524$	$t = -1.155$	$t = 2.224$	$t = 2.155$	$z = 2.382$
Constant	−0.007	0.029	−0.044	−0.118	
	$t = -0.293$	$t = 1.454$	$t = -0.999$	$t = -1.522$	
Observations	4,530	2,263	2,267	1,135	
R^2	0.001	0.001	0.002	0.008	
Adjusted R^2	0.0004	0.0001	0.002	0.006	
Note:					*p<0.1; **p<0.05; ***p<0.01

respectively. The differences are also significant at the 5% level.

Interestingly, the full sample coefficients, although positive, are not statistically significant. This could be due to the shorter time period of the sample, which excludes the highly volatile years at the turn of the millennia. Likewise, the results indicate that during times of crisis, when uncertainty and fear rises, global financial markets tend to move in unison (see e.g., Ang & Bekaert, 2002; Jiang, Yu, & Hashmi, 2017).

Overall, the above results indicate that the ECB monetary policy meeting cycle does not provide similar resolution of uncertainty and subsequent returns in the stock market. On the other hand, the FOMC biweekly cycle appears to be present for European stocks as well. It provides further backing to the unique role of the Federal Reserve as an exemplar in setting monetary policy and the interconnectedness of the global financial markets as suggested by Brusa et al. (2020) and Rey (2015).

The uniqueness of the FOMC meetings may come down to its long roots and established meeting cycle. Furthermore, in forming the ECB cycle based on the U.S. model we do not account for the different working schedules and cultures of the two committees. One such example is the ECB governing council's non-monetary policy meeting which occurs every two weeks after and before the monetary policy meeting in the current meeting cycle. This may reduce the informational value of the monetary policy meeting. Unfortunately, the dates of these non-monetary policy meetings are not available historically.

7. Conclusion

This study focuses on the intersection of uncertainty, Federal Open Market Committee and the stock market. Prior research has found a biweekly cycle in stock returns which follows the Fed's Open Market Committee's monetary policy meetings. Days that occur in even weeks in FOMC cycle time, as defined by Cieslak et al. (2019), are responsible for almost all of the equity premium in 1994-2019. We find evidence that the Fed's impact on the stock market is especially strong during times of heightened uncertainty. Specifically, even week days that occur during the top quartile of days, as measured by VIX, have multiple times higher returns than even week days that occur during low uncertainty. In contrast, we find virtually no evidence of an even week premium during times of low uncertainty. These results are statistically significant and robust to other macroeconomic announcements, company earnings announcements, stock market returns and calendar effects. We also present three pieces of evidence to support the causal relationship between VIX and the even week premium. First, investors' interest in the Federal Reserve, as measured by Google search volume, increases at times of high VIX. Second, the FOMC tends to make rate cuts rather than hikes during times of uncertainty. Finally, the Fed communicates more actively with the market when implied volatility is high.

Our results have implications for both investors and policymakers, and the society. The Fed-centricity that uncertain times cause might require investors to fine tune their investment strategies. Furthermore, unequal access to informal monetary policy information can lead to some investors questioning their trust in the fairness of the markets. Lastly, the central bankers might need to reconsider how they formulate and communicate their policies, if they do not recognize how important role markets are willing to cast them at times of uncertainty. Furthermore, an excess fixation on the Fed might reduce investors' focus on the real economy and company fundamentals and lead to mispricing, bubbles and consequent crashes, which can have extremely negative effects on the society. Finding empirical evidence of these topics provides interesting avenues for possible further research.

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8. Appendix

Table XII: Regressions of Daily U.S. Stock Returns on FOMC Cycle Dummies by Year, 2007-2019

This table presents results of regressions of daily excess U.S. stock returns on FOMC cycle dummies. The analysis is run over yearly samples between 2007 and 2019. The left-hand-side variable is in percent, so (for example) 0.1 means 10 bps per day. Holidays are included with returns set to zero.

	Dependent Variable: Excess Return on Stocks over T-Bills												
	Year												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
week 0	0.128	0.935**	0.459	−0.071	−0.096	0.033	−0.115	0.137	0.188	0.198	0.018	−0.476**	−0.139
	$t = 0.734$	$t = 2.115$	$t = 1.512$	$t = -0.347$	$t = -0.355$	$t = 0.228$	$t = -0.915$	$t = 1.031$	$t = 1.106$	$t = 1.305$	$t = 0.225$	$t = -2.509$	$t = -0.952$
week 2, 4, 6	−0.009	0.277	−0.071	0.309*	0.288	−0.074	−0.065	0.052	0.286**	0.189	0.005	−0.109	−0.008
	$t = -0.065$	$t = 0.810$	$t = -0.303$	$t = 1.967$	$t = 1.385$	$t = -0.658$	$t = -0.654$	$t = 0.504$	$t = 2.161$	$t = 1.623$	$t = 0.084$	$t = -0.734$	$t = -0.075$
Constant	−0.008	−0.380*	0.062	−0.023	−0.065	0.080	0.155***	0.008	−0.112	−0.041	0.071*	0.085	0.121*
	$t = -0.101$	$t = -1.818$	$t = 0.428$	$t = -0.239$	$t = -0.509$	$t = 1.147$	$t = 2.643$	$t = 0.129$	$t = -1.405$	$t = -0.571$	$t = 1.842$	$t = 0.955$	$t = 1.744$
Observations	261	262	261	261	260	261	261	261	261	261	260	261	261
R^2	0.002	0.017	0.011	0.018	0.010	0.002	0.004	0.004	0.019	0.013	0.0002	0.024	0.004
Adjusted R^2	-0.005	0.010	0.003	0.011	0.002	-0.005	-0.004	-0.003	0.011	0.005	-0.008	0.016	-0.004
F Statistic	0.309	2.258	1.451	2.413*	1.278	0.313	0.507	0.556	2.465*	1.687	0.025	3.147**	0.476

Note: *p<0.1; **p<0.05; ***p<0.01

Table XIII: Regressions of Daily U.S.Stock Returns on FOMC Cycle Dummies by Year, 1994-2006

This table presents results of regressions of daily excess U.S. stock returns on FOMC cycle dummies. The analysis is run over yearly samples between 1994 and 2006. The left-hand-side variable is in percent, so (for example) 0.1 means 10 bps per day. Holidays are included with returns set to zero.

	Dependent Variable: Excess Return on Stocks over T-Bills												
	'Mkt-RF'												
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
week 0	0.070	0.053	−0.005	0.173	0.204	0.361*	0.251	0.184	−0.259	0.457**	−0.129	0.120	−0.115
	$t = 0.669$	$t = 0.622$	$t = -0.038$	$t = 0.962$	$t = 0.933$	$t = 1.869$	$t = 0.915$	$t = 0.749$	$t = -0.927$	$t = 2.514$	$t = -1.021$	$t = 1.024$	$t = -0.975$
week 2, 4, 6	0.132	0.027	−0.043	0.110	0.211	0.203	0.380*	−0.294	0.152	0.340**	0.051	0.091	−0.116
	$t = 1.611$	$t = 0.401$	$t = -0.445$	$t = 0.787$	$t = 1.221$	$t = 1.361$	$t = 1.794$	$t = -1.556$	$t = 0.688$	$t = 2.368$	$t = 0.519$	$t = 1.003$	$t = -1.252$
Constant	−0.065	0.084**	0.071	0.028	−0.021	−0.044	−0.221*	0.016	−0.090	−0.063	0.045	−0.035	0.092*
	$t = -1.313$	$t = 2.091$	$t = 1.206$	$t = 0.333$	$t = -0.205$	$t = -0.483$	$t = -1.685$	$t = 0.138$	$t = -0.694$	$t = -0.749$	$t = 0.756$	$t = -0.618$	$t = 1.663$
Observations	260	260	262	261	261	261	260	261	261	261	262	260	260
R^2	0.010	0.002	0.001	0.005	0.007	0.016	0.013	0.015	0.007	0.035	0.007	0.006	0.008
Adjusted R^2	0.002	-0.006	-0.007	-0.003	-0.0005	0.008	0.005	0.008	-0.001	0.028	-0.001	-0.002	-0.00004
F Statistic	1.322	0.221	0.103	0.604	0.938	2.113	1.692	2.003	0.911	4.681**	0.877	0.794	0.994

Note: *p<0.1; **p<0.05; ***p<0.01

Table XIV: Regression of Monthly "Federal Reserve" Google search volume and VIX, 2004-2019

This table presents results of regressing the monthly relative number of Google search volume for "Federal reserve" on the average level of VIX that prevailed the previous month. We report t-statistics calculated with Newey-West (default lags) standard errors robust to heteroscedasticity and autocorrelation. For further details refer to Figure 6 and the accompanying section.

	Dependent Variable: Monthly Relative Google Search Volume for "Federal Reserve"
	(1)
Average VIX	0.520^{***}
	$t = 3.719$
Constant	37.579^{***}
	$t = 12.025$
Observations	191
R^2	0.094
Adjusted R^2	0.089
Note:	*p<0.1; **p<0.05; ***p<0.01

Table XV: Regression of Fed Funds Target Rate Changes on VIX, 1994-2019

This table presents results of regressing the magnitude of Fed funds target rate changes on the average level of VIX over the past 20 trading days. The left-hand-side variables are in percent, so (for example) 0.1 means 10 bps impact on magnitude of target rate change. We report t-statistics calculated with Newey-West (default lags) standard errors robust to heteroscedasticity and autocorrelation. For further context refer to Figure 7 and the accompanying section

	Dependent Variable: Fed Funds Target Rate Change
	(1)
Previous 20-day average VIX	-0.023^{***}
	$t = -4.647$
Constant	0.434^{***}
	$t = 3.990$
Observations	72
R^2	0.370
Adjusted R^2	0.361
Note:	*p<0.1; **p<0.05; ***p<0.01