Unconventional Times and Unconventional Reactions: The Effects of U.S Monetary Policy Announcements on Financial Markets

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Abstract

By using the event study technique with the two proxies for monetary policy surprises which are the *target surprise* and the *path surprise* it was documented that Federal reserve communication announcements affect financial markets significantly moreover, it was shown that different financial assets react to different factors of monetary policy surprises. For example, the exchange rates and ten-year interest rates respond mainly to the path surprise while stock prices and short-term interest rates respond mainly to the target surprise. Furthermore, to discuss whether the response of financial asset prices to monetary policy surprises varies in different times in terms of monetary policy implications in the US, this study compared the estimates of the pass-through of monetary policy shocks on financial assets before and after QE and further, considered the asset price reactions in recession and non-recession times with high-frequency data. It was shown that the effects of these monetary policy surprises have a different pattern in different times. All the financial markets' responses (except equity index) to the target surprise were insignificant after QE whereas all exchange rates' reactions to the path factor after QE are significant and also the magnitude of these responses have increased. Therefore, these findings supported two arguments which suggest the effects of US dollar on international exchange rates has become more influential after the Fed's unconventional monetary policy and to adequately capture the effects of monetary policy on financial markets, at least two factors are needed.

Conversely, even though the volatility of financial asset prices during the recession times is higher than the non-recession times, it was shown that in recession times there was no significant effects of the target and path policy surprises on the financial markets. It was interpreted that in recession times the Fed becomes more transparent or the markets predict the Fed's actions well. Another striking aspect of this finding is that the volatility of financial asset prices during the recession times was higher than the non-recession times thus, it was assumed that the sources of this volatility are not the Fed policies but other news. Therefore, here again, it was suggested that using daily or wider windows during the recession time will cause a mis-identification problem.

Keywords: Central Bank Communication, FOMC Statement, Monetary Policy Shocks
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1 Introduction

This research explores how financial markets react to the Federal Open Market Committee (FOMC) statements by considering a high-frequency dataset that covers from 1996 to 2017. We document the effects of the surprises of US monetary policy announcements on domestic financial assets and three main exchange rates at different times. In addition, we considers the extent to which the response of financial asset prices to monetary policy surprises varies in different times with high-frequency data such as conventional and unconventional times in terms of US monetary policy implications.

There is a plethora of evidence to suggest that Fed monetary policies have always been important for domestic as well as international financial markets. How financial assets respond to Fed monetary policy is of crucial interest not only for academics but also important for monetary policy makers. The Fed itself, for instance, estimates how well its actions are predicted by financial agents, given that market participants can adjust their views on future monetary actions and other expectations such as expectations of inflation, unemployment rate, and output growth based on these actions. All these expectations will have an important impact on the overall economy. Therefore, information about the likely market reaction to monetary policy allows the Fed to assess the immediate success of any action that has been taken such as, whether or not the reactions of financial participants to the monetary policy change are in accordance with the Fed's intentions. Hence, the measurement of monetary policy surprises and their effects on domestic and international markets has become an important task for policy makers and economists.

This research primarily deals with questions such as how such unexpected occurrences in monetary policy and their sources are determined and how these events affect domestic and international financial markets. This research closely relates to that of Gürkaynak et al. (2005) and Hausman and Wongswan (2011) which investigate the effects of the FOMC statement on domestic and international assets. In addition to them, this research explores two main arguments. First, the considerable importance of the event window size in capturing exact monetary policy surprise. To avoid an identification problem, it is suggested that intradaily data rather than daily data is used, particularly in recession times. Second, after recent crisis, the Fed lowered its key interest rate near to zero and the short-term interest tool was no longer available for use. Thus, the Fed turned to other tools such as large-scale asset purchasing (commonly known as *quantitative easing*) and increased communication strategy (such as forward guidance policy). Hence, we argue that using these new and different tools may cause different monetary policy surprises/results than previously. For example, it is anticipated that increasing communication strategy and zero lower bound policy

might lead to a decrease in monetary policy surprises, particularly short-term surprises. In this regard, firstly intradaily and daily sub-samples are constructed, then investigated at different times of monetary policy to see how surprises change over time.

In his seminal paper, Kuttner (2001) estimated the impact of the anticipated and unanticipated changes in the Fed fund target rates on a wide range variety of interest rates bill, notes, bonds. Kuttner (2001) assumed that the federal fund futures contracts could be used as a market expectation tool to measure monetary policy surprises by using the event study method. It was found that bonds' reactions to *expected* changes is primarily zero, while their reactions to *unexpected* surprises in the fed fund target rate is large and highly significant. The study further demonstrated that monetary policy surprises have a sizeable effect on long-term interest rates, thus, concluding that there is a strong and significant relationship between *unanticipated* policy *actions* and market interest rates. Bernanke and Kuttner (2005), adopting the same event study methodology as Kuttner (2001), investigated the effects of changes in monetary policy of Fed on stock market prices rather than interest rates. It was shown that there is a negative relationship between changes in stock prices and unexpected changes in the Fed funds target rate. They documented that, on average, a hypothetical unexpected 25-basis-point (bsp) cut (increase) in the federal funds target rates is associated with about a 1% rise (decrease) in broad stock indexes. The results also showed that equity prices respond strongly to the surprise changes in the funds rate, but respond little, if at all, to the component of funds rate changes expected by fed fund future contracts. Hence, the results of Bernanke and Kuttner (2005) are consistent with Kuttner (2001) as regards reactions to the surprise changes across equity and interest rates, respectively. Both looked at the US financial market and used a daily event window length. The main results of these two pioneering papers are widely parallel with those of other research which used a different methodology but examined at the connection between monetary policy surprises and the financial asset prices. For example, using the *vector auto-regression (VAR)* method, Thorbecke (1997) demonstrated a strong reaction of equity prices to monetary policy shocks. Moreover, Rigobon and Sack (2004) found a significant response of stock prices to the interest rate shocks derived from Euro-dollar futures contracts by using *Identification through Heteroskedasticity* technique, which is the heteroskedasticity-based estimator for correcting possible simultaneity bias.

Despite the novelty and efficacy of Kuttner (2001), his study suffers from several limitations. First, its use of a 1-day length window which is quite long in terms of precision. As Neely (2015) suggested, the window size is a key element of the event study, and it must be neither too long and not too short. A longer window might be influenced by the impact of other surprises on financial

markets, while a shorter window may be unable to obtain the full impact of the monetary policy surprises. The second inadequacy is that Kuttner (2001) used only a single factor, namely, the current target factor was used to measure the surprise effects of Fed policy on financial asset prices. The model of Kuttner (2001) is:

$$R_{i,d} = \alpha + \beta_1 TS_d + \varepsilon_{i,d} \tag{1}$$

where R_i is a proxy of interest rates and $R_{i,d}$ is the return of each i asset price on the day d, which is the day on which the FOMC announcement occurred. TS_d is the target factor surprise, and $\varepsilon_{i,d}$ is a residual term. Hence, the returns of each i asset price depend upon one single surprise factor that is the target factor.

In contrast, Gürkaynak et al. (2005) argued that to adequately capture the effects of Fed policy surprise at least two factors are needed namely the *"current federal funds rate target"* factor and also a *"future path of policy"* factor. The former is the same as that used by Kuttner (2001); the latter is the factor associated with FOMC statements regarding future policy. However, Kuttner (2001) only considered the effects of *changes* of the Fed monetary policy, either anticipated or unanticipated. In contrast, Gürkaynak et al. (2005)'s model,

$$R_{i,d} = \alpha + \beta_1 TS_d + \beta_2 PS_d + \varepsilon_{i,d} \tag{2}$$

where $R_{i,d}$ is the return of each i asset prices. R_i are S&P 500 for the stock index and interest rates which are 2 and 5-Year Treasury notes/bills on the day d. TS is the target surprise, PS is the path surprise, and $\varepsilon_{i,d}$ is a residual term. In contrast to Kuttner (2001), with Equation-2 Gürkaynak et al. (2005) argue that the returns of each i asset price do not depend upon one single factor alone but two.

In simple terms, Gürkaynak et al. (2005) showed that financial markets react not only to the *actions* or changes in monetary policy but also (and larger) to the *words* of FOMC meetings such as the potential position of future monetary policy. For instance, in the case of the FOMC statement after the meeting of January 28, 2004, 2- and 5-year Treasury yields jumped 20 and 25 bps respectively just after from the announcement representing the largest reaction over 14 years for 1990 to 2004. Of note here, is that there was no policy change with this announcement but the decision to keep the current interest rate unchanged, and this was completely predicted by financial market participants. Consequently Gürkaynak et al. (2005) claimed that such a large reaction came not from what FOMC *did* (action) but rather what FOMC *said* (words). Therefore, using only a single

factor which is the *target factor* to gauge financial market reactions to the monetary policy would miss the full story.

With this research I extended the existing literature in three ways. First, I examine the reactions of the US domestic asset prices (stocks and interest rates) and three main exchange rates to FOMC statement surprises by considering intradaily and daily dataset. Furthermore, it documents FOMC surprises during the period from January 1996 to November 2017. The sample of financial asset prices is the most up to date and largest possible, subject to data availability constraints. Our comprehensive dataset that includes more monetary policy announcements than previously used in other studies such as Neely (2015) and Wright (2012) . In particular, during and after the recent financial crisis, many studies focused solely on how monetary policy shocks have affected the financial markets. For instance, Kuttner (2001)'s dataset covers 42 interest rate change announcements from June 6, 1989, to February 2000; Bernanke and Kuttner (2005)'s sample contains the 55 target rate changes and the 77 FOMC statement announcements from June 1989 to December 2002, ignoring the 17 September 2001 announcement, for a total of 131 announcements; Hausman and Wongswan (2011) investigates all FOMC statement events from February 4, 1994, to March 22, 2005; Gürkaynak et al. (2005) looked from January 1990 through December 2004. Conversely, other research focuses only on unconventional monetary policy times, for example, Wright (2012) which concentrated only on the period from November 3, 2008 to September 30, 2011; Bauer and Neely (2014) considered only 9 Large Scale Asset Purchasing(LSAP) events from 2008 to 2012. Similarly, Neely (2015) examined 8 LSAP events from 2008 to 2009, Rogers et al. (2014) FOMC announcements from 2008 to 2014. Lastly, Glick and Leduc (2015) looked at 17 FOMC announcements during 2008-2013. On the other hand, our dataset covers over 21-year period from January 1996 to November 2017 which is a total of 188 FOMC statement announcements. In addition, we have different sub-sample to investigate further on the role of unconventional monetary policy period, and recession times. Second, following Gürkaynak et al. (2005), two proxies are used for Fed monetary policy surprises as opposed to the single proxy used in most studies and further, it finds additional evidence that monetary policy surprises contain more than just a surprise in the announced target rate as in Kuttner (2001). Third, in parallel with the idea of Boyd et al. (2005)'s research[1] that some economic news might have a different effect on the financial markets in different times, this study further investigates how the monetary policy surprises affect the financial

[1] Boyd et al. (2005) examined unemployment rate announcements and their effects on the US stock markets and found that if the unemployment rate is higher than expected, this announcement led stock prices to increase during expansion times, but not during recession times. This suggests that an important macroeconomic announcement might have different effects in different times even if the announcement itself is the same.

market during the recession and non-recession times as well as conventional and unconventional times. This means that an important macroeconomic announcement might have different effects at different times even if the announcement itself is the same. In parallel with this approach, it is argued that the Fed announcement can have a different impact at different times.

The remainder of this research proceeds as follows. Section-2 outlines the event study methodology in details. Section-3 provides an introduction to the future contracts and discusses their ability to reflect the market expectation. Section-4 identifies and constructs the surprise components of monetary policy announcements in the US and emphasises the necessity of having two surprise components, namely, the target and path surprise to capture the full extent of monetary policy announcements. Section-5 describes econometric model. Then follows a discussion of the data in section-6 by investigating the importance of the event window length on determination of monetary policy surprises and section-7 outlines the results and suggests implications regarding the data and measurements of monetary policy surprises. Finally, section-8 presents concluding remarks, limitations of this research and further potential research.

2 Event Study Methodology

The efficient markets hypothesis assumes that market prices adjust quickly to any new information and prices should also reflect all information available. For example, in the minutes before the information or news related to asset prices is released, its content is unknown to financial market agents. After the news release, with efficient markets, the content of the news is quickly adjusted and conveyed by financial asset prices. In this regard French and Roll (1986) and Neely (2015) showed that asset prices react relatively rapidly to news. Thus, changes in price reflects markets' reactions to the new information received before or after any changes in financial market. In other words, changes in asset prices to be correctly identified in a narrow window around the unexpected information that occurs after the news; a window which reflects no more than the *casual* effects of this news. This identification method is known as the event study technique and is used in this research.

According to recent finance literature, the event study is an appropriate method for determining the immediate effects of any surprise information on the market(Neely, 2015). The rationale for this method is that forward-looking financial markets should quickly incorporate all new information from a public announcement immediately after the announcement is made. Intuitively, financial participants would not be predicted to forgo large, risk-less, profitable trading opportunities for

more than a couple of days or even hours, and thus the impact would be reflected in prices within a short period following monetary policy announcements that include new information (surprises) for financial markets. In this study, the event study technique measures the effects of monetary policy surprises by looking at the reaction of prices around a pre-defined window of the policy action. This is a simple yet powerful measurement of the changes. The event study methodology is based on the efficient market hypothesis that assumes any new information available to the markets is incorporated by the related asset prices and any changes in this information set over a small time window around it, should be reflected by changes to the asset price in the very short time. The second central assumption of this method is that no other related news comes within the announcement window. In simple terms, the event study method investigates the responses of the financial markets to new information in a pre-defined window.

Given rationality in the market place or under the efficient market condition, the usefulness and effectiveness of such a method come from the fact that the impact of a related event will be conveyed shortly in financial asset returns. Therefore, a measure of the event's financial effect can be constructed using these asset returns observed over a relatively short time period which is called "the event window". Through this research, the event study method has been applied to see the immediate impacts of Fed monetary policy announcements on the financial asset prices.

Even though the event study method has a long history which goes back to 1930s, for example Dolley (1933) investigated the effects of stock splits on the nominal price changes at the time of the split. By improving this method Fama et al. (1969) introduced the event study technique which is almost the same as in use today. Amongst other Roley (1982), Fleming and Remolona (1999), Rudebusch (1998), and Ellingsen and Soderstrom (2001) are the seminal papers of the event study (MacKinlay, 1997). The method has fast become a key instrument in measuring the effects of monetary policy announcements on asset prices and economic fundamentals recently. Simply, the event study method offers a solution on measurement the effect of an event of interest over a pre-defined period. For instance, if one is looking at the effects of a recent unemployment report on stock prices with daily data, the event is here the release of unemployment report and the event window is a one-day period. Therefore, the main task of conducting an event study is first to determine the event of interest and define the period of interest. For instance, in the unemployment report case, the stock index might obtain information about the reports before the actual release and it can be examined this possibility by investigating pre-event returns. In our case, this research looks at the asset prices just before the Fed monetary policy announcement and after the announcement then investigates whether these differences are abnormal or not.

The event study method on the monetary policy analysis was popularised by Kuttner (2001). In addition to Kuttner (2001), Bernanke and Kuttner (2005) also investigated the effects of the US monetary policy news on financial asset by using the same method with daily data. Furthermore, Ehrmann and Fratzscher (2003) have applied the same method for the European Central Bank (ECB) to the European financial markets and have found that ECB communication has considerable effects on European financial asset prices. In a similar vein, Andersson (2010) analysed the responses of exchange rates to economic news and proved that there is an important relationship between the two. Apart from central bank announcements or news, the event study method has also been used in a variety of different case. Boyd et al. (2005), for example, examined unemployment rate announcements and their effects on the equity prices in the US. It was found that if the unemployment rate was unexpectedly high, this announcement led stock prices to increase during expansion times, though, not during recession times. Rigobon and Sack (2005) showed that a rise in the probability of the war against Afghanistan in 2003 caused stock prices to decrease and increases oil futures quotes. Similarly, by using an event study Snowberg et al. (2013) further demonstrated the relationship between stock market prices and changes in perception of which candidate will win on election day.

3 Market Expectation Tool: Basic Concepts of Futures Contracts

There are many different financial market instruments to anticipate the future of monetary policy such as Treasury bills, fed funds futures, Euro-dollar futures, Euro-dollar deposits and federal funds loans, all of which differ in their liquidity and risk characteristics and thus, their ability to capture monetary policy shocks. For example, Kuttner (2001) uses the current month federal contracts, Gürkaynak et al. (2005) and Hausman and Wongswan (2011) the current month fed fund futures and Euro-dollar futures contracts, Rigobon and Sack (2003) the three-month Euro-dollar futures rate, and Ellingsen and Söderström (2004) the three-month Treasury bill rate. In this respect, Gürkaynak et al. (2007) investigated different financial market tools for forecasting monetary policy at various horizons. It was found that the best measure of surprise for the immediate policy setting is fed funds futures rates which were used by Kuttner (2001), while for a more long-term perspective, which is the expected near-term policy path rather than the immediate policy setting, it was concluded that Euro-dollar future contracts seem a better tool. Therefore, in this research, owing to their forecasting ability, the fed fund futures contracts are used to proxy the target surprise as in Kuttner (2001) while 1-Year Euro-dollar futures are used for the path surprise, similar to Gürkaynak et al.

(2005), Hausman and Wongswan (2011), and Glick and Leduc (2015).

Futures contracts[2] are cash settled based upon the average daily effective target rate, as published by the New York Fed, during the course of the delivery month. These futures contracts provide an efficacious means of hedging and gaining exposure to interest rate risks. In simple terms, the fed funds futures are contracts with pay-outs at maturity, relied on the average effective federal funds rate during the expiration month. Futures contracts are a valuable market predictive tool since they reflect the common marketplace insight regarding the future stance of Fed policy. According to the CME, fed fund futures have a number of key benefits. They provide a gauge of market expectations about the Fed's action at future FOMC meetings. In addition, they offer trading in transparent markets with low transaction costs, daily market-to-market and the virtual elimination of counter-party credit risk. Furthermore, futures contracts offer liquid tools to manage risk or hedge against changes in Fed monetary policy. Fed fund futures and Eurodollar futures have the same structure. In this research, one-month current contract Fed fund futures and one-year ahead Eurodollar futures contracts have been used. These contracts were introduced in the literature of monetary policy announcements by Kuttner (2001) and extended by Gürkaynak (2005).

Technically, the fed funds futures contract is quoted per the "IMM Index" or the price of fed futures contracts is 100 minus the expected Fed funds effective rate. Every contract represents the average overnight federal funds rate for the contract month. The value of the contract (ff) at expiration is $100 - r$, where r is the average effective federal funds rate over the expiry month. If the particular contract for instance, March 11, 2003 is priced 98.77, then it is understood that the market predicts the implied average fed funds effective rate for March 11, 2003 as 1.23% (100-98.77). Thus, it can be formulated:

$$\mathbb{E}[r] = 100 - ff \tag{3}$$

where $\mathbb{E}[r]$ is the expected interest rate and ff is the futures contract price.

Therefore, the market anticipation of the interest rate from the fed fund futures contracts' price can be determined at any time. For example, if the current Fed funds target rate is 1% which means that $r = 1$ and the futures contract rate is $ff = 98.770$, then the expected interest rate is;

$$\mathbb{E}[r] = 1.23\% = 100 - ff = 100 - 98.770 \tag{4}$$

[2]CME Group's 30-Day Fed Fund futures contracts and 1-Year ahead Eurodollar futures contracts were used. These securities have been trading on the Chicago Board of Trade (CBOT) since late 1988. CME is one of the largest exchange groups in the world for more information: http://www.cmegroup.com

$$\mathbb{E}[\Delta(r)] = \mathbb{E}[r] - r \tag{5}$$

where $\mathbb{E}[\Delta(r)]$ is the expected *change* in interest rate and r is the current interest rate.

Equation 5 implies that the market is expecting that the FOMC will increase the rate of 25 basis points ($\mathbb{E}[\Delta(r)] = 1.23\% - 1 \approx 0.25\%$) . This is due to the assumption that market participants have already priced their expectation prior to the announcements. However, if the contract price is 98.95, this suggests that the expected federal funds rates is 1.05% (100-98.95), therefore 0.05 (1.05%–1%) basis points indicates that markets do not expect any shift in rates with the upcoming FOMC meeting at that time. Moreover, the monetary policy surprise based on futures contract price is;

$$Surprise = \mathbb{E}[\Delta(r)] - \Delta(r) \tag{6}$$

where $\Delta(r)$ is the actual interest rate change and the surprise is the difference between expected change and actual change in the interest rate.

4 Measurement of Monetary Policy Surprises

In order to fully understand the effects of monetary policy, monetary policy surprises should be measured. However, measuring such surprises is not an easy task, given that the federal funds target rate and other asset prices are jump variables. This means that their price can change dependent upon changing expectations (Sargent and Wallace (1973); Gürkaynak (2005)). Thus, it is hard to identify monetary policy impact with quarterly or monthly data due to the problem of overlapping observations. In order to overcome this problem, Cook and Hahn (1989) considered the policy action as an independent variable in their research. However, the efficient market hypothesis assumes that asset prices respond only to unexpected policy actions, which necessitates the measurement of surprise components. For instance, if a monetary policy announcement contains a substantial and entirely expected change, it will not affect asset prices or portfolio reallocation, as monetary policy will already have been priced in. Hence, to have a correct estimation of the impact of monetary policy, it is vital to measure the surprise components of monetary policy, and not only use dummy variables to isolate the (monetary policy announcement) days, as is common in the literature. For example, Rai and Suchanek (2014) used a dummy variable for each Fed announcement to estimate the effects of Fed tapering on emerging market economies. The study presumed that all FOMC statements are equal and identical. In contrast, Gürkaynak (2005) and Chen et al. (2014)

identified that the results are markedly different, if the magnitudes of monetary policy shocks are not controlled. Therefore, identifying and measuring the surprise components is one of the major elements of estimating the impact of monetary policy on asset prices. This section deals with the initial part of the task, namely, the identification of monetary policy surprises using high-frequency data.

Two proxies have been used for U.S. monetary policy surprises as opposed to the single proxy used in Kuttner (2001). Gürkaynak et al. (2005) provided evidence that monetary policy surprises contain more than just a surprise in the announced target rate. Further, the study showed that two factors are needed to capture the full extent of monetary policy surprises, one for the current target rate (target surprise) or the short-term surprise and the second for the expected path of future monetary policy for the future monetary policy surprise. The target surprise is the degree to which market participants have been able to anticipate the actual monetary policy decisions. The path surprise instead measures to what extent market participants have revised the future expected monetary policy path following the actual decision and/or monetary policy statements.

4.1 The Target Surprise

The target surprise can be defined as the difference between the announced target fed funds rate and anticipations derived from the futures contracts. The target surprise is computed from the change in the current-month fed funds futures contract rate in a precise time window around FOMC announcement. These futures enable market agents to place a bet in the month t on the average effective Fed target rate during the current or future month, represented as r_{t+m}, and $m \geqslant 0$. For example, a market participant on day d in month t can get at a fixed rate at the end of the month $t+m$ thus it can be symbolised by $ff_{d,t}^{(m)}$. For instance, if $m = 0$ then the contract is for the current month t, if $m = 1$ then it is for the next month, symbolised as $t + 1$, and so forth. Thus, $ff_{d,t}^{m}$ contract rate represents the market expectation of the average effective federal fund rate, r_{t+m}:

$$ff_{d,t}^{m} = \mathbb{E}_{d,t}[r_{t+m}] + \eta_{d,t}^{m} \tag{7}$$

where $\eta_{d,t}^{m}$ is a risk premium and $\mathbb{E}_{d,t}[r_{t+m}]$ is the market expectation of the target rate on the day d in month $t + m$.

Therefore, if an FOMC meeting is scheduled to take place on day d_0 of a month $t + 0$ with total D days, the rate of fed funds futures contract $ff_{d-1,t}$ which is the one day before $(d - 1)$ the

announcement in the current month ($m = 0$) would be:

$$ff_{d_0-1,t} = \frac{d_0}{D_0} r_0 + \frac{D_0 - d_0}{D_0} \mathbb{E}_{d_0-1,t}(r_1) + \eta_{d_0-1,t} \tag{8}$$

where $ff_{d_0-1,t}$ is the closing-contract price on one-day before $(d_0 - 1)$ FOMC announcement day (d_0) in month t.

Equation-8 simply shows that $ff_{d-1,t}$ is a weighted average of the fed funds rate (r_0) that has prevailed so far (d days) in the month t and the rate (r_1) is that which is expected to prevail for the remainder $(D - d$ days) of the month plus a risk premium, $\eta_{d_0-1,t}$. By evaluating the equations-8 one-day ahead which is at the end of day d_0, we can reach:

$$ff_{d_0,t} = \frac{d_0}{D_0} r_0 + \frac{D_0 - d_0}{D_0} (r_1) + \eta_{d_0,t} \tag{9}$$

where $ff_{d_0,t}$ is the contract price at the end of FOMC announcement day in month t. Note that in both equations-8 and 9, m is zero and so $ff_{d_0,t}$ equals $ff^0_{d_0,t}$ but for simplicity, this is not denoted.

Equation-8 shows the rate of the contract just one day before FOMC meeting and the second equation-9 shows the new contract rate after FOMC meeting. These equations can be used to identify monetary policy shocks. As the futures contract rate will incorporate all information available to the markets, thus, any change in the futures rate over a small time window around FOMC statements will reflect changes in market predictions. Therefore, to see FOMC meeting surprise which is the unanticipated component of the monetary policy action is given by differencing the equation-8 from 9, known as the *Target Surprise*(TS) is: :

$$TS_{d_0,t} \equiv \mathbb{E}_{d_0-1,t}[r_1] - [r_1] \tag{10}$$

$$TS_{d_0,t} = [(\Delta ff_{d_0,t}) - (\Delta \eta_{d_0,t})] \frac{D_0}{D_0 - d_0} \tag{11}$$

where $\Delta ff_{d_0,t} \equiv ff_{d_0,t} - ff_{d_0-1,t}$ and $\Delta \eta_{d_0,t} \equiv \eta_{d_0,t} - \eta_{d_0-1,t}$. Similar to Gürkaynak (2005), it is assumed that the risk-premium[3] is constant thus, $\Delta \eta_{d_0,t} = 0$ in such a short time window where 20 minutes in our case. Hence, a policy surprise after FOMC announcement can be computed in the future contract rate at the end of FOMC meeting day from the one day before. It can be seen that

[3]More detailed discussions on risk-premium see Piazzesi and Swanson (2008)

the target surprise, $\mathbb{E}_{d_0-1,t}[r_1] - [r_1]$, is:

$$TS_{d_0,t} = \frac{D_0}{D_0 - d_0}(\Delta ff_{d_0,t}) \tag{12}$$

In a simple terms, the target surprise daily is defined as $TS_d = \frac{D}{D-d}(ff_d - ff_{d-1})$ where d is the announcement day and $d-1$ is the one day before the announcement, ff is the 30-days Fed fund futures. Similarly, target surprise intradaily is defined as $TS_d = \frac{D}{D-d}(ff_{\tau+10} - ff_{\tau-10})$ where τ is the time of the announcement in day d. Hence $\tau + 10$ means 10 minutes after the announcement and $\tau - 10$ is 10 minutes before the announcement.

4.2 The Path Surprise

Although the target surprise (TS) may provide the best measure of unanticipated shifts to the immediate policy setting, this research is interested in expectation changes about the future policy at the next FOMC meeting. For instance, financial agents might shortly expect a potential federal funds rate cut, however, they cannot be sure whether this will occur with the next meeting or the meeting thereafter.To analyse shocks related to the current and future rate policy, the market expectation of average rates within specific intervals should be gauged: between the current and the next FOMC meeting, between the next meeting and the meeting thereafter, and so on so forth. These are only expectations, thus the surprises cannot be measured with the 1-month fed fund futures and so TS, in this regard, as in Hausman and Wongswan (2011) used a second surprise component, which is the path surprise, to capture the full extent of monetary policy.

Essentially, the target surprise is aimed at gauging the effects of current policy decision while the path surprise is intended to reflect news about any revision in monetary policy in the future. For this reason, in order to capture the long-time surprise, the path surprise is also used as a second surprise component. The similar method of target surprise is followed to gauge changes in expectations about r_2, the federal fund target rate that will prevail after the second FOMC meeting from now. If ff denotes the futures contract rate for the month containing the second FOMC announcement, then

$$ff_{d_0-1,t} = \frac{d_1}{D_1}\,\mathbb{E}_{d_0-1,t}[r_1] + \frac{D_1 - d_1}{D_1}\,\mathbb{E}_{d_0-1,t}[r_2] + \eta_{d_0-1,t} \tag{13}$$

where d_1 and D_1 are the day of that the second FOMC announcement and the number of days in the month containing this second FOMC meeting. Similarly, $\eta_{d_0-1,t}$ reflects the risk premium at the same as before. r_1 the interest rate after the first FOMC meeting and r_2 is the interest rate after

the second FOMC meeting. Therefore, the first part of the equation-13 is the expectation of the interest rate for the first FOMC ($\mathbb{E}_{d_0-1,t}[r_1]$) on day $d_0 - 1$ and the second part of the equation-13 is the expectation of the interest rate for the second FOMC ($\mathbb{E}_{d_0-1,t}[r_2]$) again on day $d_0 - 1$. By evaluating the above equations ahead one day:

$$ff_{d_0,t} = \frac{d_1}{D_1}[r_1] + \frac{D_1 - d_1}{D_1}\mathbb{E}_{d_0,t}[r_2] + \eta_{d_0,t} \tag{14}$$

Thus, equation-14 indicates that r_2 needs to be predicted again with the new information available after the first FOMC meeting. $\mathbb{E}_{d_0,t}[r_2]$ denotes the expectation of r_2 on day d_0 where r_1 is already known after the first FOMC meeting. Differencing the equation-13 from the 14 then the path surprise is:

$$PS_{d_0,t} \equiv \mathbb{E}_{d_0,t}[r_2] - \mathbb{E}_{d_0-1,t}[r_2] \tag{15}$$

in detailed form:

$$PS_{d_0,t} = [(\Delta ff_{d_0,t}) - \frac{d_1}{D_1}TS_{d_0,t}]\frac{D_1}{D_1 - d_1} \tag{16}$$

where $\Delta ff_{d_0,t} \equiv ff_{d_0,t} - ff_{d_0-1,t}$ and again the risk-premium ($\Delta\eta_{d_0,t} = 0$) is constant. For the intradaily path surprise:

$$PS_{d_0,t} = [(\Delta ff_{d_0,\tau,t}) - \frac{d_1}{D_1}TS_{d_0,\tau,t}]\frac{D_1}{D_1 - d_1} \tag{17}$$

where $\Delta ff_{d_0,\tau,t} \equiv ff_{d_0,\tau+10,t} - ff_{d_0,\tau-10,t}$

5 Econometric Model

Conducting an event study research on the effects of monetary policy requires the fulfilment of at least two main tasks; measuring, firstly, the surprise(s), and secondly, the effects of these surprises on asset prices, respectively. These tasks can be best performed with high-frequency data since it is a requirement to have a small-enough window around the news, and further that nothing other than the news should be affecting asset prices. If the window is longer, other surprise information will matter too, though, we argue that the daily window is too long to validate this assumption. For example, as Table-11 shows that FOMC announcement dates frequently coincide with other relevant macroeconomic announcements such as *Unemployment Reports*. In this case, other news will affect

the asset prices and so the volume and direction of surprises. Therefore, we suggest that using the intradaily data as an alternative, particularly for the analysis of the recession period since in recession or crises times the number of other important events, which are the potentially influential to the surprise components are more frequent then normal times and also markets become more sensitive to news during these times. Hence, this study argues that only high-frequency data can achieve this identification problem since in a small enough window around the news announcement, nothing other than the announcement should affect asset prices. Otherwise, for example, with a longer window, other shocks will matter and further, will contaminate the measurement.

Following Rigobon and Sack (2003), Rigobon and Sack (2004), and Gürkaynak and Wright (2013) the econometric modelling set-up is a system of two simultaneous structural equations that depend on a financial asset price. For example, stock price and a macro variable or monetary policy announcement on each other:

$$\Delta i_t = \beta \Delta r_t + \gamma z_t + \epsilon_t \tag{18}$$

$$\Delta r_t = \alpha(\Delta i_t - E\Delta i_t) + \delta z_t + \eta_t \tag{19}$$

in which Δi_t is the actual interest rate change and $E\Delta i_t$ is the expected change. Δr_t is the changes in financial asset prices which are equity index (S&P500 Index), exchange rates (Euro, British Pound and Japanese Yen), interest rates (1 and 3-Month,1-Year, and 10 -Year Treasury bonds) in this case. z_t is a vector of other variables that might have effects, both on the announcements (i_t) itself and the financial asset price (r_t). Lastly, ϵ_t and η_t are uncorrelated error terms.

Equation 18 denotes a monetary policy response function that covers the anticipated response of a policy to a set of other variables z_t and to the financial asset price r_t. Equation 19 is the financial asset price equation, that illustrates the asset price to be influenced by the FOMC announcements, i_t and also by the other variables, z_t.

Different from Rigobon and Sack (2003), the parameter of interest of this research is the α rather than β . The parameter of β is measuring the reaction of the monetary policy to the financial asset price changes, while this study is interested in the parameter α that measures the effects of the unanticipated FOMC announcements, $\Delta i_t - E\Delta i_t$ on the financial asset prices Δr_t.

However, it is a well-known fact that Equation 18 and 19 cannot be estimated consistently by using the ordinary least squares (OLS) due to the presence of simultaneous equations and omitted variables. Hence, the OLS estimation of the pass-through, α is biased since both variables, Δi_t

and Δr_t , are simultaneously determined in the system.

To understand the difficulty of the econometric estimation, let us consider the system of Equation 18 and Equation 19 in matrix form :

$$\begin{pmatrix} 1 & -\beta \\ -\alpha & 1 \end{pmatrix} \begin{pmatrix} \Delta i_t \\ \Delta r_t \end{pmatrix} = \begin{pmatrix} \gamma \\ \delta \end{pmatrix} z_t + \begin{pmatrix} \epsilon_t \\ \eta_t \end{pmatrix} z_t \tag{20}$$

having solved, one can obtain the reduced-form solution of the system:

$$\begin{pmatrix} \Delta i_t \\ \Delta r_t \end{pmatrix} = \frac{1}{1-\alpha\beta} \left\{ \begin{pmatrix} \beta\delta + \gamma \\ \alpha\gamma + \delta \end{pmatrix} z_t + \begin{pmatrix} 1 \\ \alpha \end{pmatrix} \epsilon_t + \begin{pmatrix} \beta \\ 1 \end{pmatrix} \eta_t \right\} \tag{21}$$

Let denote σ_ϵ^2 is for the variance of monetary policy shock, σ_η^2 and σ_z^2 are for the variance of asset price shocks and other shocks, respectively. The OLS estimate:

$$\hat{\alpha}_{OLS} = \frac{Cov(\Delta i_t, \Delta r_t)}{Var(\Delta i_t)} \tag{22}$$

$$= \frac{(\beta\delta + \gamma)(\alpha\gamma + \delta)\sigma_z^2 + \alpha\sigma_\epsilon^2 + \beta\sigma_\eta^2}{\beta\delta + \gamma)^2\sigma_z^2 + \sigma_\epsilon^2 + \beta^2\sigma_\eta^2} \tag{23}$$

hence, the bias of the OLS estimate could be

$$\hat{\alpha}_{OLS} - \alpha = (1 - \alpha\beta)\frac{\beta\sigma_\eta^2 + \delta(\beta\delta + \gamma)\sigma_z^2}{\sigma_\epsilon^2 + \beta^2\sigma_\eta^2 + (\beta\delta + \gamma)^2\sigma_z^2} \tag{24}$$

According to the Equation 24 the OLS estimate is biased due to both

- simultaneity bias - if $\beta \neq 0$ and $\sigma_\eta^2 > 0$
- omitted variables bias - if $\gamma \neq 0$ and $\sigma_z^2 > 0$

To deal with this problem many studies focus on the narrow windows immediately surrounding the FOMC announcement using what has been known as event study methods that are largely used in literature such as Cook and Hahn (1989); Thorbecke (1997); Kuttner (2001); Bernanke and Kuttner (2005); Gürkaynak et al. (2005), and Hausman and Wongswan (2011).

The main logic $\beta \neq$ behind the event study method is that the bias in the OLS estimate will be limited if the following conditions hold to minimise the bias of the estimator.

$$\sigma_{\epsilon}^2 \gg \sigma_{\eta}^2 \tag{25}$$

$$\sigma_{\epsilon}^2 \gg \sigma_{z}^2 \tag{26}$$

in which case $\hat{\alpha}_{OLS} \cong \alpha$. In the limit, if σ_{ϵ}^2, the variance of the monetary policy shock becomes infinitely large relative to the variances of the other shocks, σ_{η}^2 and σ_{z}^2 or mathematically $\sigma_{\epsilon}^2/\sigma_{\eta}^2 \implies \infty$ and $\sigma_{\epsilon}^2/\sigma_{z}^2 \implies \infty$ therefore, the biases go to zero, and the OLS estimate now becomes consistent.

Nevertheless, the window lengths are generally of one or two-day length which is insufficient to remove this bias. Within a one-day period, for instance, there might be many other shocks such as unemployment report or growth rate announcements might appear and these might affect financial asset prices; thus, the affected asset prices alone will no longer be able to correctly convey the effect of the monetary policy announcement. Therefore, as shown in the previous chapter, these conditions 25 and 26 may not hold, and the size of the bias could remain in those OLS estimates.

Under these circumstances, an event study with high-frequency data may offer a solution. For example, if a short enough window is considered, not even a day but minutes around an announcement, then it is reasonable to claim that the variance of shocks σ_{η}^2 and σ_{z}^2 are small, relative to the variance of the shock to the news,σ_{ϵ}^2. Then, Equation 19, can be simply estimated by an OLS regression of Δr_t on Δi_t. The equation is estimated over windows that include only one announcement.

Hence, the empirical methodology of this research examines asset price returns over a 40-minute window around the FOMC announcement specifically 15 minutes before and 25 minutes after the FOMC announcement. Specifically, for each asset class on days in which the FOMC announcements took place, the regression is run:

$$\Delta r_{x,d,\tau} = \alpha + \beta_1 TS_{d,\tau} + \beta_2 PS_{d,\tau} + \varepsilon_{x,d,\tau} \tag{27}$$

where $\Delta r_{x,d,\tau}$ is the return of each (x) asset class in the 40-minute window on the announcement

day d at the announcement release time τ. $TS_{d,\tau}$ is the target surprise, $PS_{d,\tau}$ is the path surprise and $\varepsilon_{x,d,\tau}$ is the residual term. Therefore, as our intradaily window is sufficiently narrow in time around the new information or surprise, it is safe to assume that the FOMC statements were in no way affected by asset price movements or other macroeconomic news during that interval. For that reason, it is much less likely any other important news occurred within this narrow window that may have affected asset prices, hence increasing the precision power of equation 27 estimates.

6 Data and Discussion

6.1 Data Information

Our dataset relies on three critical components, namely the selection of announcements, determination of window length, and identification of monetary policy surprises in different periods. The selection of announcements is crucial for all event study research. All announcements of FOMC statements are used, including both regularly scheduled and unscheduled FOMC meetings between January 1996 and November 2017 and due to their importance guvernors' speeches at the Jackson Hole conferences. In our benchmark specification, the complete sample consists of a total of 188 observations. The FOMC meeting just after the 9/11 terrorist attack in the US might have an outlier effect on financial markets, therefore, September 17, 2001 FOMC decision has been excluded, given the identification challenge. Simply, we estimate the effects of US monetary policy announcements on financial assets: (i) stock prices (ii) exchange rates and (iii) short and long-term interest rates. Further, it is assumed that the conventional period ends on November 25, 2008, which is the date at which quantitative easing started. The period after this date is called "NEW ERA" (coined by Bernanke (2017)), or unusual times regarding monetary policy. Hence, unconventional monetary policy times refers to this period which is from November 25, 2008, to the end of 2017. Thus, the conventional period herein includes 110 announcements while the unconventional period has 78 announcements. Further, the second sub-sample regarding the recession times is based on National Bureau of Economic Research(NBER) specification[4]; the dataset has two recession periods namely dot-com bubble (from March 2000 to November 2001) and mortgage crises (December 2007 to June 2009). The first recession has 15 announcements , and the latter one has 18 hence a total of 33 announcements in recession times.

[4]NBER which defines the recession as a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales. http://www.nber.org/cycles.html

Table 1. Summary Statistics

All Times	From January 1996 to November 2017				
Variables	Obs	Mean	Std. Dev.	Min	Max
Policy Changes (bps)	188	-1.99	19.67	-75.00	50.00
S&P500 (%)	188	0.10	0.91	-1.85	7.01
EUR (%)	188	0.01	0.41	-2.03	1.25
GBP (%)	188	-0.03	0.38	-1.89	1.18
YEN (%)	188	-0.02	0.51	-2.26	1.13
10-Year (bps)	188	-0.71	8.50	-46.70	26.70
1-Year (bps)	188	-0.61	8.63	-50.00	46.00
3-Month (bps)	188	0.09	12.83	-32.50	97.50
1-Month (bps)	188	-1.63	13.01	-125.00	51.50
Target Surprise (bps)	188	-1.16	8.15	-46.15	26.00
Path Surprise (bps)	188	-0.85	9.52	-53.59	50.53

Notes: This table shows basic statistics for proxies for monetary policy announcements surprises and asset price returns in intradaily window length. The sample period includes all FOMC statements from January 3, 1996 to November 11, 2017, excluding the September 17, 2001 FOMC statement announcements.

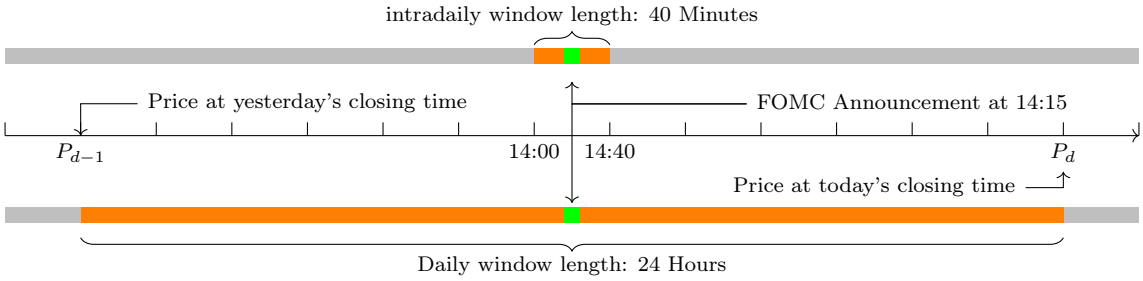
Table-1 shows basic statistics for policy changes and all dependent variables for the FOMC statements. Fed policy action (*Policy Changes*) is the action of the Fed after a FOMC meeting, so it can be a cut in target rate or increase as well as no change. Thus, *Policy Changes* do not require an actual *change* in the interest rate but it is a decision. The standard deviation of the policy change is higher than those of surprise factors indicating the fact that policy changes take place in 25-bps change and are anticipated. Changes in stock prices and exchange rates are represented by a percentage while the changes in policy, interest rates are in basis points. The volatility of exchange rates which are in 0.4-05% range is similar, however, the volatility increases while the maturity of interest rates decreases. For example, the standard deviation of the ten-year interest rate is 8.50 basis point while the standard deviation of the one-month short-term interest rate is 13.01 basis point. This is in line with expectation since the short-term notes/bill are more volatile.

6.2 The Importance of the Event Window Length

The window size is one of the critical elements of event studies. Event window length must be neither too long nor too short. A longer window might pick up the effects of other shocks on financial markets, whereas a shorter window might not pick up the full effect of the monetary policy shock. In this regard, Gürkaynak and Wright (2013) suggest that windows should be as small as possible. However, unavailability[5] of intradaily data for financial assets might be the main reason why researchers prefer to use daily window instead of intradaily window, in recent empirical works on event studies. Using a longer window increases the danger of any contamination in the estimation window. Although the FOMC statements are mostly announced at 14:15, some FOMC announcements occurred at a different time such as the inter-meeting press release of September 29, 2008 meeting which was announced at 10:00. Therefore, it can be concluded that using high-frequency data in this study affords more precise estimation and greater flexibility.

Mindful of these concerns, in this research, both intradaily and daily data are used to ascertain how different they are. Similar to Gürkaynak et al. (2005), Hausman and Wongswan (2011) and Neely (2015) a small size window was used, at first, namely, a 40-minute window (15 minutes before the announcement and 25 minutes after the announcement). Thereafter, a second the longer one of a one-day event window was used, similar to that used by Kuttner (2001), Doh and Connolly (2013), and Bernhard and Ebner (2017). This window takes the closing price one-day before (P_{d-1}) the announcement and the closing price (P_d) of the announcement day, where d is the announcement day. As can be seen in Figure-1, the application in this research assumes a one-day window and 40-minute window for the FOMC statement.

Figure 1. Event Study Window Lengths



[5]The intradaily data, more commonly known as 'tick data', which is mostly a premium data and sold by third-party data companies, one of which has been purchased for this study. For example, the Bloomberg terminal gives, at most, three-month intradaily data access, while the Thomson Reuters DataStream provides only daily data. Companies like Haver Analytics, Tick-Data, and Genesis sell this type data independently.

$$\Delta[ff_d] = P_d - P_{d-1} \tag{28}$$

where $\Delta[ff_d]$ is the change of contract prices for the daily window and P_d and P_{d-1} are the price of the contract on announcement day and one day before, respectively. However, if our window is intradaily and of 40-minute length, then the equation-28 becomes;

$$\Delta[ff_\tau] = P_{\tau+25} - P_{\tau-15} \tag{29}$$

where $\Delta[ff_\tau]$ is the change of the contract prices for the intradaily window and $P_{\tau+25}$ and $P_{\tau-15}$ are the price of the contract on the day of announcement, 25-minutes after the announcement and 15-minutes before the announcement, respectively.

Thus, changes in the futures contract price are calculated as the difference in the closing price on the day of a FOMC announcement relative to the previous day's close or the price at 15 minutes before the announcement and the price at 25 minutes after the announcement in the case of intradaily. FOMC statements are mostly announced at 14:15, hence, in this case, the length of the window is 40 minutes for the intradaily data (upper part of Figure-1) and 1-Day for daily data (below in Figure-1). The second assumption is that no other market-related news takes place during the window period. If there is a coincidence with important news that might affect financial markets (for example, an announcement of unemployment rate, growth rate, political crises, or a natural disaster) our calculation will potentially be contaminated.

6.2.1 intradaily vs Daily Windows. Table-2 shows the measurements of monetary policy surprises, namely, the target and the path surprise with daily and intradaily windows. The format of the table is as follows: the first row of each is for the intradaily surprise and the second represents the same surprise component with its daily window. Thereafter, the third rows of each component show the differences considering their window lengths. Target and path surprises vary considerably related to their windows size. The target factor intradaily has a standard deviation of 8.15 basis points, with a minimum realisation of -46 basis points and a maximum of 26 basis points. The target surprise with a daily window, however, has 9.09 basis points with a minimum realisation of almost -75 basis points and a maximum of 30 basis points, hence, the volatility of daily target surprise windows is almost 20% higher than its intradaily windows for the whole period. In addition to target surprise, path surprises also vary considerably depending on the window size. The standard deviation of intradaily path surprise is 9.52, whereas the standard deviation of path surprise with

daily windows is 14.77, the difference is almost 35%.

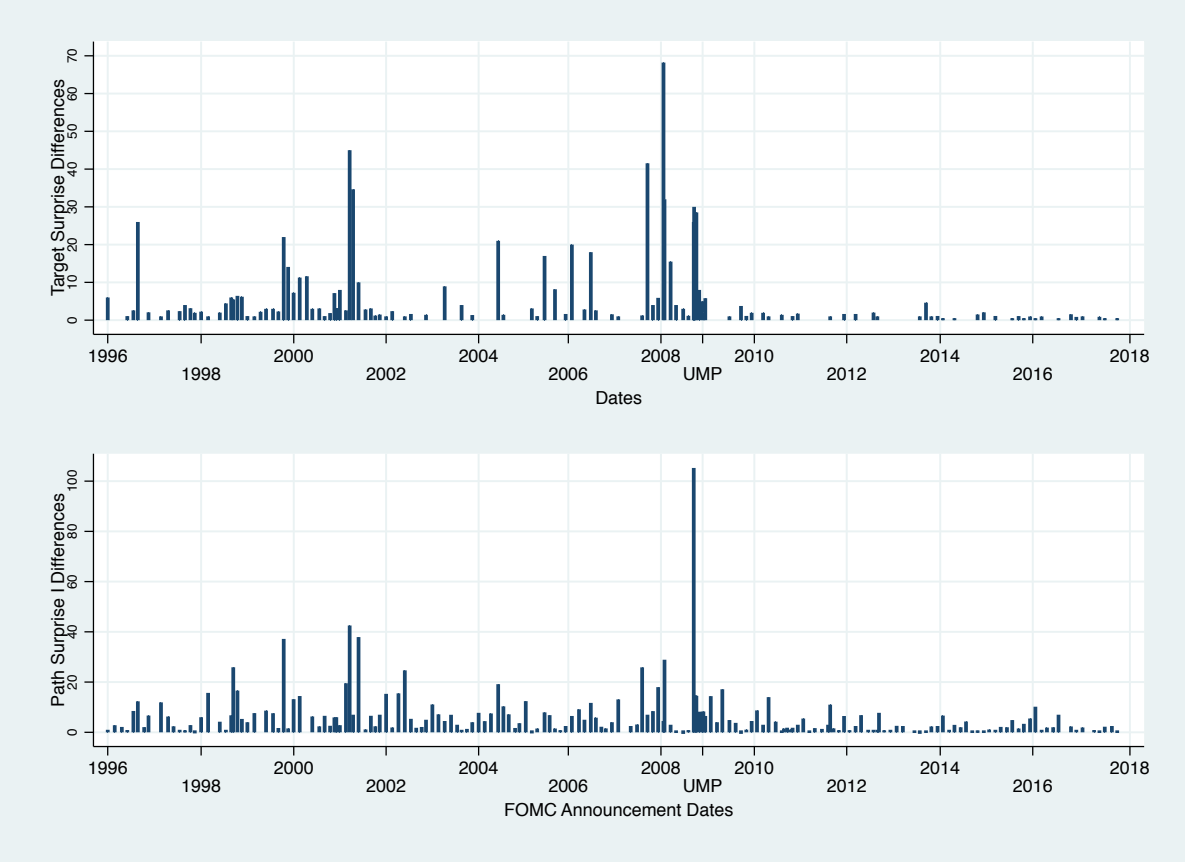
Table 2. Summary Statistics for All FOMC Statements

Variable	Obs	Mean	Std. Dev.	Min	Max
All Times					
Policy Changes (bps)	188	-1.995	19.673	-75.00	50.00
Target Surprise(TS) intradaily(Int)	188	-1.16	8.15	-46.15	26.00
Target Surprise Daily(Day)	188	-1.16	10.16	-74.40	30.00
Difference of TS Int & Day (Absolute)	188	3.96	8.81	0.00	68.20
Path Surprise intradaily (bps)	188	-0.85	9.52	-53.59	50.53
Path Surprise Daily (bps)	188	-0.53	14.77	-72.94	96.25
Difference of PS Int & Day (Absolute)	188	6.22	10.03	0.00	105.25

Notes: This table shows basic statistics for proxies for monetary policy announcements surprises in intradaily and daily window length. The sample period includes all FOMC statements from January 3, 1996 to November 11, 2017, excluding the September 17, 2001 FOMC statement announcement.

Furthermore, Figure-2 shows the dispersion of each surprise for every announcement based on their window size. This indicates that the differences between target surprise and path surprise by considering both their intradaily and daily window on every announcement. Consistent with expectation, the difference between intradaily and daily target surprise is almost zero over the zero lower bound period. However, the path surprises are shown to be more sensitive to interest changes in contrast to the target surprise, particularly, during the financial crisis, when the path surprise fluctuated considerably. For the path surprise even though the dispersion becomes lower at the zero lower bound period, differences can still be seen in the table. In both cases, during the recent financial crises, the daily and intradaily surprises have responded entirely differently from each other. Overall, the differences between intradaily and daily windows for the path surprise are larger than that of the target surprise. This shows two important inferences; firstly, the importance of the two-dimensional surprise component as Gürkaynak et al. (2005) suggests, in capturing the full extent of monetary policy, which is the second component is the path surprise and secondly, the importance of the event window size on understanding the effects of US monetary policy on financial assets.

Figure 2. The Differences of intradaily and Daily Target and Path Surprise Over Time



Notes: Figures show that the absolute differences between intradaily and daily target surprise as well as intradaily and daily path surprise by considering both their window on every announcements.

Apart from summary statistics, Table-3 provides more insightful information regarding the differing impact of intradaily and daily window size. Table-3 shows the ten largest movements in the target surprises for intradaily and daily window, respectively. The first panel of the table indicates the intradaily surprise and the second represents the surprise that has occurred in daily windows. Further, the first column of the table entitled *Dates* shows the date when the largest surprise occurred. The second column of the table entitled *Action* indicates the change (if any) in the monetary policy rate. The third column indicates the actual monetary policy rate at that time. The fourth column shows intradaily surprises, and the fifth column is for daily surprises. The sixth column indicates the difference between intradaily and daily surprise, and the final column shows whether other economic news occurring on that day which might affect the surprise component. The complete list of other macroeconomic news that occurred in the event windows (daily) can be seen in Appendix.

Table 3. Largest Movements in intradaily and Daily Target Surprises

(A)	Ten Largest Movements for the intradaily Window					
(1) Dates	(2) Action	(3) Rate	(4) **intradaily**	(5) Daily	(6) Difference	(7) Other News
18/09/2007	-50	4.5	-45	-42	3	PPI
18/04/2001	-50	6	-26	-29	3	NA
16/12/2008	-50	4.75	-20	-16	4	CPI, Housing Starts
03/01/2001	-75	0.25	-19	-16.5	2.5	NA
06/11/2001	-50	2	-15	-10.5	4.5	NA
06/11/2002	-50	1.25	-15	-16	1	NA
24/09/1996	0	5.25	13	-13	26	Consumer Confidence
25/06/2003	-25	1	13	12.5	0.5	Durable Goods Order
16/09/2008	0	2	13	9	4	CPI
27/06/2001	-25	3.75	11	8.5	2.5	NA
(B)	Ten Largest Movements for the Daily Window					
Dates	Action	Rate	intradaily	**Daily**	Difference	Other News
22/01/2008	-75	3.5	-2	-52	50	NA
18/04/2001	-50	4.5	-45	-42	3	International Trade
03/01/2001	-50	6	-26	-29	3	NA
29/10/2008	-50	1	-6	-21.5	15.5	Durable Goods Order
18/03/2008	-75	2.75	11	21	10	PPI, Housing Starts
16/12/2008	-75	0.25	-19	-16.5	2.5	CPI, Housing Starts
06/11/2002	-50	1.25	-15	-16	1	PPI
18/09/2007	-50	4.75	-20	-16	4	NA
19/09/2008	0	2	0	16	16	NA
01/11/2005	25	4	0	15	15	Construction Spending

Notes: Table in Panel A shows the ten largest movements in the target surprises for intradaily and table in Panel B shows in daily window.

In this respect, the last row, entitled *Other News*, shows the potential risk of using daily windows. In daily windows, if other financial or non-financial news has occurred on this day which may affect market participants' view, then the surprise cannot represent solely the surprise view coming from the Fed announcement, rather it incorporates other news as well. Hence, under these conditions, it is hard to say if the daily surprise reflects the exact monetary policy shock which is isolated from other shocks. Therefore, a longer window runs the risk of picking up the effects of other shocks on financial markets which violates the central assumption of the event study method.

Table 4. Largest Movements in intradaily and Daily Path Surprises

(A)	Ten Largest Movements for the intradaily Window					
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dates	Action	Rate	**intradaily**	Daily	Difference	Other News
18/04/2001	-50	4.5	-37	-18.5	18.5	International Trade
16/12/2008	-75	0.25	-34	-28	6	CPI, Housing Starts
28/01/2004	0	1	24	20	4	Durable Goods Orders
18/09/2007	-50	4.75	-23	-15.5	7.5	PPI
11/12/2007	-25	4.25	20.3	-17.5	37.8	NA
06/11/2001	-50	2	-18	-15.5	2.5	NA
18/03/2009	0	0.25	-17	-32	15	CPI
15/05/2001	-50	4	-15	-4.5	10.5	NA
25/06/2003	-25	1	14.5	22.5	8	Durable Goods Orders
06/05/2003	0	1.25	-14	-17	3	NA

(B)	Ten Largest Movements for the Daily Window					
Dates	Action	Rate	intradaily	**Daily**	Difference	Other News
19/09/2008	0	2	-1.5	53	54.5	NA
29/09/2008	0	2	7.5	-47.5	55	PCE
18/03/2009	0	0.25	-17	-32	15	CPI
16/12/2008	-75	0.25	-34	-28	6	CPI, Housing Starts
22/01/2008	-75	3.5	-5	-28	23	NA
25/11/2008	0	1	1.5	-26.5	28	LSAP Started
25/06/2003	-25	1	14.5	22.5	8	Durable Goods Orders
26/06/2002	0	1.75	0.5	-21	21.5	Durable Goods Orders
28/01/2004	0	1	24	20	4	Durable Goods Orders
18/03/2008	-75	2.75	5.5	19.5	14	PPI, Housing Starts

Notes: Table in Panel A shows the ten largest movements in the path surprises for intradaily and table in Panel B shows in daily window.

This can be easily identified from Table-4. Table indicates that the ten largest surprises differ from each other. Moreover, even on the same day, the magnitude of surprise is different, and daily surprise is, as expected, mostly higher than the intradaily one. For example, on 18/03/2009 the Consumer Price Index (CPI) was announced and the path surprise on this day was -17 bps for intradaily and -32 bps for daily windows. In fact, it may also have had the reverse effect, namely, a piece of news that could equally cause downward impact on the surprise effect of the Fed announcement. For instance, the market could be negatively affected by a surprise Fed announce-

ment, but in the same day, there may be another news that causes this surprise effect to decrease. Therefore, Table-3 indicates other macroeconomic announcements which may potentially affect the surprise components; it is hard to identify whether this surprise is coming solely from the FOMC announcement itself or other macroeconomic news. On the whole, it is concluded that windows size is essential in determining monetary policy surprises and daily window is not an effective choice for this.

Three main reasons might explain the differences between intradaily and daily surprises. First, the surprises might not persist over the window time. For example, the market can immediately react to the FOMC decision as soon as it is announced, however, thereafter this reaction can return instantly to its previous position. In this case, intradaily window will be able to reflect the first shock even though it is not persistent; in contrast, no shock will appear at the end of the day for the daily window. As aforementioned, of primary interest are these shocks regardless of whether or not they are persistent. Second, due to its longer window, there might be different macroeconomic news during the time around the window, which might have a different directional impact on the market. Thus, this may neutralise the effect of the FOMC announcement. For example, if the FOMC decision prompts a negative change after the announcement in the early morning, then there could be other macroeconomic news such as a higher employment rate than the market predicted, thus, this second news might also have a positive effect on the market. Overall, at the end of the day, the daily window is once more unable to represent the size of the FOMC surprise, moreover the daily window is unable to reflect whether the FOMC gave a positive or a negative shock to the markets due to this neutralisation. The last reason for this dispersion may originate from the inability to select the news by intradaily windows. For example, in recent years the financial markets have become more complicated and so too has monetary policy and its tools. In such a complex environment, digesting the FOMC announcement, and, in particular, anticipating the effects on the long-term and making a decision based on this anticipation, requires more time than previously. Therefore, intradaily windows such as a 5-minute window cannot pick up the exact effects of the FOMC statement. However, to deal with this problem, a 40-minute window length has been used. Moreover, it should be stressed that in this study, every single 40-minute window has been controlled over the dataset totalling 188 events, none of which coincide with the different announcements. Thus, the financial market has only one important event within 40 minutes over the dataset and it is reasonable to assume that any price volatility comes from the FOMC actions.

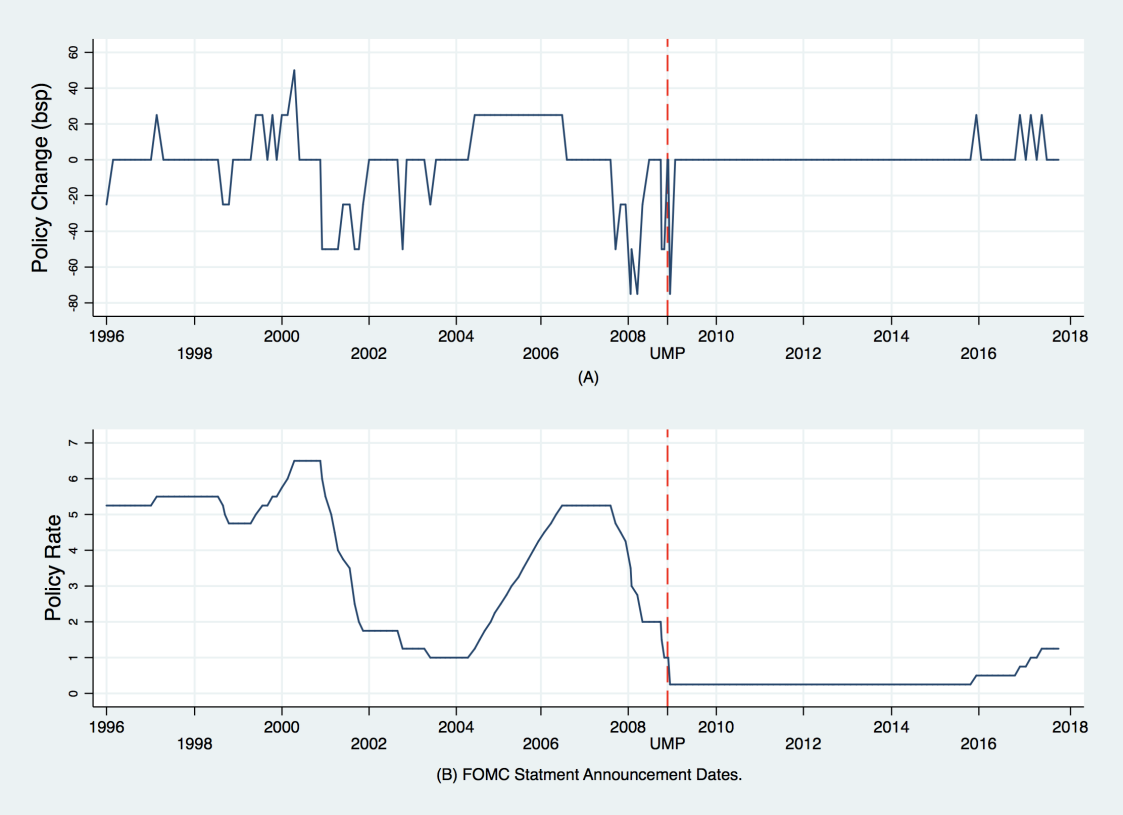
6.3 Patterns of Monetary Policy Surprises in Different Times

6.3.1 Conventional vs Unconventional Monetary Policy Times. As explained by Galí (2015), the conventional monetary policy is that which uses the short-term interest rate as well as other asset price instruments including exchange rates, equity prices, and credit channels. Normally, the conventional monetary policy tools are enough to stabilise the economy, however, not when the economy experiences a full-scale financial crisis like the one experienced recently. Following the collapse of Lehman Brothers, the fed fund target rate fell near to zero and did not increase until the end of 2015 (see Figure-3).

According to Blanchard (2013), after the recent global financial crises, neither monetary policies nor their impact on the financial markets was the same as before. In this regard, Bernanke (2017) named this period *"a new era"*. In parallel with Blanchard (2013)'s suggestions, it is argued in this study that unconventional monetary policies might lead to different monetary policy surprises and these, in turn, might cause different effects on financial markets than the conventional ones. Therefore, it is assumed that the conventional period ended on November 25, 2008, the date on which the first quantitative easing was announced. The advantage of using this sample split is that it makes this sample of unconventional policy announcements more comparable to that which has been typically used in the literature.

Under these circumstances, the Fed had to turn to unconventional monetary policies such as forward guidance and large-scale asset purchasing. However, the zero lower bound period does not mean that there were no monetary policy shocks for domestic and international financial markets after FOMC announcements. For example, on September 18, 2013, the Fed did not change fed funds rate, and market participants did not predict any differently than the Fed *did*. However, FOMC announcements had much substantial and unanticipated information relevant to future monetary policy in the next months or years. It is claimed, therefore, that monetary policy shocks resulting from using these unconventional instruments in unconventional times will have a different size and different pattern from conventional ones. This hypothesis is in parallel with Gürkaynak et al. (2005) which indicates that central banks *actions* such as changing the interest rate, do not always have to be more influential than their *words*.

Figure 3. Fed Policy Rates.



Notes: Figure shows the Fed's monetary policy rate and its changes in basis points (bps) from January 1996 to November 2017. The dashed line indicates the start of U.S. unconventional monetary policy (UMP) on November 25, 2008. The first graph shows policy rate changes in bps unit and the second graph shows the Fed fund target rate, which is known as the policy rate, from 1996 to the end of 2017.

Table-5 provides summary statistics for policy change and two surprise factors before and after the unconventional monetary policy begin (commonly known as quantitative easing). The table format is similar to Table 2. However, Table 5 provides a comparison opportunity between surprise statistics before and after quantitative easing. Similarly, the first panel rows show the statistics of the surprise component before the quantitative easing period, which is the period from January 31, 1996, to November 25, 2008(not including). The second panel shows the statistics after quantitative easing, from November 25, 2008 (inclusive) to November 2017(inclusive) for all FOMC statements. According to Table-5 the standard deviation (SD) of all surprise components and policy actions became smaller after quantitative easing. However, the daily surprises decrease somewhat more than intradaily windows as expected. For example, the SD of target surprise with intradaily windows was 9.5 bps prior to quantitative easing, however, thereafter, it decreased by 39% to 5.79, while the decrease in the standard deviation of the daily target was 55% after November 25, 2008. This can also

be seen with different components. For example, the standard deviation in the difference between target surprise with the intradaily and daily target window became almost zero (1 basis point) by a decrease of 90% after quantitative easing. This is consistent with the expected consequences of the zero lower bound period given that the target surprise is mainly related to the short-term interest rate change which remained unchanged from 2008 to the end of 2015. In addition to the target surprise, the SD of the path surprise with intradaily windows has also decreased from 12 bps to 4 bps representing a decrease of 66%. The path surprise is always higher than the target surprise, regardless of time and window length which shows that the short-term prediction ability of the market is better than that for the long-term.

Table 5. Summary Statistics for Different Periods

Variables	Obs	Mean	Std. Dev.	Min	Max
January 31, 1996 to November 25,2008					
Policy Change (bps)	110	-3.636	24.145	-75	50
Target Surprise (TS) intradaily(Int) (bps)	110	-1.03	9.50	-46.15	26.00
Target Surprise Daily(Day) (bps)	110	-1.18	11.13	-74.40	30.00
Difference of TS Int & Day (Absolute)	110	6.23	10.94	0.00	68.20
Path Surprise intradaily (bps)	110	-0.95	12.00	-53.59	50.53
Path Surprise Daily (bps)	110	-0.07	18.67	-72.94	96.25
Difference of PS Int & Day (Absolute)	110	8.35	12.36	0.00	105.25
November 25, 2008 to November 1, 2017					
Policy Change (bps)	78	0.321	10.267	-75	25
Target Surprise (TS) intradaily(Int) (bps)	78	-1.34	5.79	-36.81	6.00
Target Surprise Daily(Day) (bps)	78	-1.14	5.05	-31.00	6.00
Difference of TS Int & Day (Absolute)	78	0.75	1.16	0.00	5.81
Path Surprise intradaily (bps)	78	-0.71	4.00	-16.88	16.44
Path Surprise Daily (bps)	78	-1.19	5.95	-20.63	25.16
Difference of PS Int & Day (Absolute)	78	3.23	3.51	0.00	17.14

Notes: Table shows basic statistics for proxies for monetary policy announcements surprises in intradaily and daily window length. The sample period includes all FOMC statements from January 3, 1996 to November 11, 2017, excluding the September 17, 2001 FOMC statement announcement. The period from January 1996 to November 2008 is assumed conventional monetary policy times while the period from November 25, 2008 to November 2017 is assumed unconventional monetary policy times.

6.3.2 Monetary Policy Surprises in Recession Times. As shown in the previous chapter, monetary policy surprises could have a different pattern in recession times relative to non-recession times, given the number of other important events that can have an impact on the surprising size in recession times. Therefore, it was suggested that measuring the surprises of monetary policy with intradaily data is more conceivable concerning identification accuracy. In this regard, the pattern of responses of asset prices response to the monetary policy surprises in recession and non-recession times is considered. Table-6 shows the basic statistics of monetary policy surprises during non-recession times (the first panel) and the recession times (the second panel).

Table-6 provides summary statistics for policy change and two surprise factors during non-recession and recession times. The format is the same as previous tables, and so the sub-dataset covers two most recent US recession periods namely dot-com bubble recession (from March 2000 to November 2001) and the recent mortgage crises period (December 2007 to June 2009). The first recession has 15 announcements, and the recent one has 18 hence totalling 33 announcements in recession times. Our recession time is based on NBER specification. According to Table-6 regardless of windows length, all standard deviations are greater in recession times as expected.

This is not only related to the policy change which has 27 bps standard deviation during recession times and 13 bps in non-recession times, almost two times higher. In addition to the evidence in section-6.2.1, Table-6 provides additional information on how window size is vital since increasing the standard deviation of policy change in recession times is not as sharp as it is with monetary policy surprise components. The standard deviation of the intradaily target surprise is, for example, 2.5 times larger in recession times than non-recession times. The striking differences exist between the daily and intradaily target and path surprises. At non-recession times, the standard deviation of the differences between intradaily and daily target surprises is 5.43 bps and 15.78 bps in recession times which is almost four times larger. Similarly, in recession times, the standard deviation of the differences between intradaily and daily path surprises is 3.5 times larger than in non-recession times.

Table 6. Summary Statistics for Recession and Non-Recession Times

Variables	Obs	Mean	Std. Dev.	Min	Max
Non-Recession Times					
Policy Change (bps)	155	2.90	13.35	-50.00	50.00
Target Surprise (TS) intradaily(Int) (bps)	155	-0.56	5.77	-46.15	16.00
Target Surprise Daily(Day) (bps)	155	-0.21	4.83	-23.25	20.00
Difference of TS Int & Day (Absolute)	155	2.45	5.43	0.00	41.54
Path Surprise (PS) intradaily (bps)	155	-0.40	8.25	-53.59	46.50
Path Surprise Daily (bps)	155	0.04	10.73	-48.23	38.75
Difference of PS Int & Day (Absolute)	155	4.82	5.68	0.00	37.18
Recession Times					
Policy Change (bps)	33	-25.00	27.24	-75.00	0.00
Target Surprise (TS) intradaily(Int) (bps)	33	-3.95	14.77	-45.00	26.00
Target Surprise Daily(Day) (bps)	33	-5.63	18.60	-74.40	30.00
Difference of TS Int & Day (Absolute)	33	11.06	15.78	0.00	68.20
Path Surprise (PS) intradaily (bps)	33	-2.97	13.99	-30.41	50.53
Path Surprise Daily (bps)	33	-3.21	26.68	-72.94	96.25
Difference of PS Int & Day (Absolute)	33	14.07	18.6	0.00	68.20

Notes: Table shows basic statistics for proxies for monetary policy announcements surprises in intradaily and daily window length. The sample period includes all FOMC statements from January 3, 1996 to November 11, 2017, excluding the September 17, 2001 FOMC statement announcement. Recession times includes dot-com bubbles and the recent mortgage crisis while Non-Recession times cover all other announcements from January 1996 to November 2017.

For that reason, this study argues that using daily windows for gauging monetary policy surprise during recessions can cause identification problems since surprises in the daily window do not actually come solely from the FOMC announcements, but rather are also affected by other news. For example, seven of the ten largest surprises for daily windows occurred after recent financial crises while only two out of ten in intradaily window for the path surprise. This can be interpreted as the result of the impact of news, other than FOMC announcements during the crises time on surprise components and further, that the daily window might be contaminated by such news. It is therefore suggested that, particularly in times of crises, the intradaily window must be taken into consideration, otherwise the magnitude of surprises cannot convey the actual surprise from the FOMC announcements.

7 Results

The equation-30 is regressed on ased on intradaily and daily data to measure all changes in the asset price, $\Delta r_{x,d,\tau}$ in which x are $S\&P500$ for stock exchanges, Euro, GBP and Yen for the exchange rates and as proxy of interest rates it is 10-Year, 1-Year, 3-Month, and 1-Month notes and monetary policy surprise factors which are $TS_{d,\tau}$ the target surprise, $PS_{d,\tau}$ the path surprise. $TS_{d,\tau}$ and $PS_{d,\tau}$ were constructed as in the previous section with intradaily data. Hence, both the dependent and independent variables are in intradaily data in the equation-30. Furthermore, to identify whether or not the estimation of equation-30 is different with daily data, it is estimated again with daily window. This time, both the dependent and independent variables are in daily data in the equation-30.

$$\Delta r_{x,d,\tau} = \alpha + \beta_1 TS_{d,\tau} + \beta_2 PS_{d,\tau} + \varepsilon_{x,d,\tau} \tag{30}$$

Panel (A) in Table-7 shows the responses of all asset prices to FOMC statement announcements in the 40-minutes window while Panel (B) shows responses for the one-day window. Asset price changes for the stock market index which is S&P 500 and the exchange rates (Euro, British Pound, and Japanese Yen) are measured as a percentage change, and interest rate changes in bond/notes yields (10- Year, 1 Year, 3-Month and 1-Month) are measured as basis-point change from 15 minutes before and 25 minutes after the FOMC announcement. In this study, the exchange rate is defined as the Euro, GBP and YEN unit per dollar. A positive(negative) change, therefore, corresponds to an appreciation (depreciation) of the US dollar (other currency). In other words, the exchange rates' response is positively correlated with interest rates in the US. Empirical expectation based on the literature of response of exchange rate is positive, and it is expected to be vulnerable to long-term surprise which is the path surprise in our case.

In summary, it is found that financial markets significantly respond to US monetary policy surprises. Further, Table-7 indicates that different financial assets respond to different factors of the US monetary policy. For example, exchange rates and long-term interest rates (10-Year) respond primarily to the path surprise while stock market indexes (S&P 500) respond to both surprises. Lastly, short-term interest rates respond only to the target surprise as expected. In addition, it is shown that one-day window results (Panel-B) are significantly different from those of intradaily.

Table 7. The Response of Financial Markets to FOMC Statements

(A)		Monetary Policy Surprises-40-Minute window						
	Target	SE	Path	SE	Cons.	SE	Obs	R-Sq
S&P500 (%)	-5.526***	(0.698)	-1.239**	(0.598)	0.0223	(0.0573)	188	0.28
EUR (%)	-0.795	(0.508)	2.901***	(0.532)	0.0181	(0.0278)	188	0.14
GBP (%)	-0.191	(0.495)	2.189***	(0.519)	-0.0249	(0.0271)	188	0.10
YEN (%)	0.664	(0.664)	2.087***	(0.696)	-0.0122	(0.0364)	188	0.06
10-Year (bps)	3.208	(10.81)	53.18***	(11.33)	-0.529	(0.593)	188	0.12
1-Year (bps)	19.29*	(11.11)	10.46	(11.64)	-0.442	(0.609)	188	0.03
3-Month (bps)	26.70***	(7.891)	0.960	(6.833)	-0.721	(0.672)	157	0.08
1-Month (bps)	33.35***	(11.52)	-1.268	(9.864)	-1.258	(0.946)	188	0.05
(B)		Monetary Policy Surprises- One-day window						
	Target	SE	Path	SE	Cons.	SE	Obs	R-Sq
S&P500 (%)	-1.058**	(0.445)	-0.965**	(0.447)	0.0576	(0.0659)	188	0.06
EUR (%)	-0.217	(0.403)	1.670***	(0.326)	0.0243	(0.0282)	188	0.13
GBP (%)	0.000280	(0.391)	1.274***	(0.317)	-0.0215	(0.0273)	188	0.09
YEN (%)	0.620	(0.514)	1.673***	(0.416)	-0.00616	(0.0359)	188	0.09
10-Year (bps)	6.672	(8.540)	23.53***	(6.911)	-0.373	(0.596)	188	0.07
1-Year (bps)	14.24***	(3.195)	-4.082	(3.210)	-0.474	(0.474)	188	0.11
3-Month (bps)	38.58***	(4.332)	5.251	(4.352)	-0.369	(0.642)	188	0.31
1-Month (bps)	12.51*	(6.395)	15.72**	(6.425)	-1.068	(0.948)	188	0.05

Notes: Table shows responses of asset prices to monetary policy surprises. The sample period includes FOMC statements from January 1996 to November 2017 which is total 188 FOMC statements(events). Interest rates are in bsp unit, and S&P500 and exchange rates are in percentage change. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table-7 shows the response of S&P500 index as a proxy of US stock markets to U.S. monetary policy for the period of 1996-2017 in intradaily windows. The negative and statistically significant estimate is *-5.53%*. The coefficient indicates that stock market returns average value is negative on the 188 announcement days. This reveals a negative relationship between US monetary policy shocks and stock market returns, which is consistent with the expectation (equity has a negative relationship with interest rate). As can be seen from the table, the reaction of equity index to short-term (target) monetary policy shocks (-5.53%) is four times greater than the response to the path factor (-1.24%). Therefore, on average, a hypothetical 100-basis point surprise cut in the fed funds rate is associated with a 5.5 percent increase in the equity index. This result is consistent with the findings of previous studies that employ similar event study techniques to examine the impact of unexpected FOMC actions on daily returns of aggregate stock market indexes. For example,

Hausman and Wongswan (2011) found that equity prices[6] respond by -3.68% to the target surprise and -0.91% to the path surprise. Similar to this result, both are statistically significant, and the response to the target surprise is almost four times greater than the response to the path surprise which is very close to the findings in this study.

Our results are consistent with recent studies' expectation (Gürkaynak et al. (2005); Hausman and Wongswan (2011)) that the exchange rate responds positively and significantly to the path surprises. Previous empirical studies suggest that the higher interest rates tend to attract the foreign investor, the higher is the demand for and value of the home country's currency. Conversely, lower interest rates tend to be unattractive for foreign investment and decrease the currency's relative value accordingly. In line with the study by Hausman and Wongswan (2011) and Glick and Leduc (2015), the results showed that exchange rates respond mainly to the path surprise. For example, as it can be seen in column *Path*, all foreign exchange rates significantly respond by *2.90%*, *2.19%*, and *2.08%* to the path surprise where the Euro is the most responsive. Exchange rates do not significantly respond to the target surprise. Therefore, Table-7 indicates that on average, a hypothetical 100-basis point surprise downward(upward) revisions in the future path of monetary policy is associated with an approximate 2.90, 2.19 and 2.09 percent decline(increase) in the exchange value of the dollar against Euro, GBP, and YEN, respectively. These results are consistent with the prediction of conventional interest rate parity, which suggests that the expected return on domestic assets should be the same as the exchange-rate-adjusted expected return on foreign assets. In other words, a decline in the US yield should be adjusted by a depreciation of the US dollar, which would boost the stimulative effect of expansionary monetary policy shocks.

Most studies in the field of asset price response to monetary policy shocks considered the response of the one class of interest rates to the monetary policy. However, in contrast to the literature, four different maturities to proxy for short and long-term interest rates were used. For example, Hausman and Wongswan (2011) used the 3-month interest rate to proxy short-term interest rate and 10-year interest rate for the long-term interest rate. In addition to Hausman and Wongswan (2011) 1-year and 1-Month interest rate were added. Hence, Table-7 shows interest rates with different maturity responses to monetary policy surprises in the US. Similarly, changes in bond yields were measured as basis-point variations within the event window. As a US monetary policy surprise transmission mechanism, the portfolio channel notes that if monetary policy changes the short-term interest rate in the US relative to the other countries, it also automatically changes the demand for government

[6] As for this research Hausman and Wongswan (2011) also used S&P500 to proxy equity market from 1994 to 2005. The dataset herein covers from 1996 to 2017, thus, comparison of the result is meaningful regarding both the time period and representative variable.

(or corporate) bonds of outside the US. Therefore, interest rates responses to US monetary policy can change through the different transmission mechanisms, that is, investing in the US treasury bond is more profitable than equity indexes within the US and other countries once the Fed increases the interest rate. Hence, it is expected that there should be a positive coefficient of interest rate responses. Table-7 shows that, on average, a hypothetical 100-basis point surprise cut in the fed funds rate is associated with about 3bsp, 19 bsp, 26 bsp, and 34 bsp decline in 10-year, 1-year, 3-month, and 1-month interest rate, respectively, while the 10-year does not significantly respond to the target surprise. Similarly, on average, a hypothetical 100-basis point surprise downward (upward) revisions in the future path of monetary policy is associated with 54, 11, 1, and -1.2 basis point surprise decline(increase) 10-year, 1-year 3-month and 1-month interest rate, respectively and again 1-year, 3-month and 1-month interest rate do not significantly respond to the path surprise.

As shown in the previous section, the event study regressions, which are based on daily data, might capture the endogenous reaction of asset prices and monetary policy to the information or news that might have been released earlier in the event day which in this case is the day of the FOMC statement announcement. Moreover, other noise from other market related news could take place throughout that day. Results of Panel (B) indicate that almost all responses are less than in Panel (A). It can, therefore, be interpreted that the one-day window is not able to reflect the shocks exactly, or some other noises from opposite directions decrease the magnitude of the response. For example, for the exchange rates, if the Fed announcement gives a positive signal for the US dollar on an announcement day, the US Dollar will be appreciated after the announcement. However, if there is another announcement towards the end of the day, that may give a negative signal for the US dollar, thus, this announcement decreases the main effect of the first Fed announcement and at the end of the day, the exact shock on the asset price is unable to be seen. Overall, the differences in responses to the FOMC statements between daily and intradaily for the stock price, exchange rate (euro/usd), and 10-Year bonds are 80%, 43% and 56% respectively, while short-term interest rates responses are similar.

7.1 Reactions in Different Times

The literature strand on the effects of monetary policy surprises on financial assets using the event study method can be divided into two parts. The studies in the first part mainly focus on 90's and early 2000s. For example, Kuttner (2001)'s dataset contains 42 changes in the target Fed funds rate from June 6, 1989, through to February 2000. Bernanke and Kuttner (2005)'s dataset covers 55 target rate changes and the 77 FOMC meeting dates for the 12-year period (from 1989-2002), for

a total of 131 observations. Hausman and Wongswan (2011) investigates FOMC statements from February 4, 1994, through to March 22, 2005. Gürkaynak et al. (2005) looked at those from January 1990 through to December 2004. All concentrate on the period before the recent financial crisis. However, some other research focuses, in contrast, only on the period after the crisis. After recent crisis, studies in the second literature strand have looked only at how such unconventional monetary policy shocks have affected the financial markets. For example, Wright (2012) concentrated solely on the period from November 3, 2008 to September 30, 2011. Bauer and Neely (2014) considered only 9 Large Scale Asset Purchasing(LSAP) events from 2008 to 2012. Similarly, Neely (2015) considered 8 LSAP events from 2008 to 2009, Rogers et al. (2014) FOMC announcements from 2008 to 2014. Lastly, Glick and Leduc (2015) looked at 17 FOMC announcements during 2008 to 2013.

However, to the best of our knowledge, no study in the literature has further investigated the comparison of the effect of monetary policies on these variables before and after QE policy. This period is entirely new as regards the recent practice of monetary policies in the US. This paper investigates the time-varying effect of monetary policy shocks on a range of financial variables using a similar approach to the one employed by the literature, which is the even study method. The comparison of the effect of monetary policy shocks on markets is important because, this will show, first, how Fed policy evolved and more importantly, how this evolving has affected financial markets. Conventionally, the fed funds rate has served as a policy instrument. However, at the zero lower bound, the Fed turns to other unconventional instruments such as large-scale asset purchases or QE, forward guidance, and operational twist. Second, an outstanding open question is whether or not the US monetary policies or US Dollar have become more powerful over time. If U.S. monetary policy affects assets, this lends support to the view that U.S. monetary policy may be a risk factor in financial markets.

As with the baseline result, to regress Equation-30, the dataset was divided into two subgroups. The first represents the conventional monetary policy time which covers from January 1996 to November 2008 (excluded). November 25, 2008, is the date that the Federal Reserve started its large-scale asset purchasing programme known as quantitative easing policy, which has never been seen in the Fed's recent history. The second subgroup of the dataset, therefore, covers from November 2008 to November 2017, included. The first panel of the Table-8 shows the regression estimation of the first group which is for the responses of asset prices to monetary policy surprise during conventional monetary policy times. Similarly, the second panel of the Table 8 is for the responses of unconventional monetary policy times.

Table 8. The Response of Financial Markets to FOMC Statements Before and After QE

Variables	Monetary Policy Surprises Before QE							
	Target	SE	Path	SE	Cons	SE	Obs	R-Sq
S&P500 (%)	-4.122***	(0.780)	-1.508**	(0.617)	-0.0580	(0.0740)	110	0.255
EUR (%)	-0.625	(0.591)	2.522***	(0.697)	0.0345	(0.0409)	110	0.123
GBP (%)	0.0628	(0.573)	1.795***	(0.676)	-0.0113	(0.0396)	110	0.062
YEN (%)	0.894	(0.774)	1.214	(0.913)	-0.0564	(0.0535)	110	0.026
10-Year (bps)	-4.374	(10.21)	37.01***	(12.03)	-0.513	(0.705)	110	0.081
1-Year (bps)	19.21*	(9.491)	3.230	(11.17)	-0.546	(0.655)	110	0.037
3-Month (bps)	26.61**	(12.25)	0.744	(9.719)	-1.857	(1.281)	79	0.060
1-Month (bps)	41.92***	(14.77)	-5.326	(11.70)	-1.727	(1.402)	110	0.070

Variables	Monetary Policy Surprises After QE							
	Target	SE	Path	SE	Cons	SE	Obs	R-Sq
S&P500 (%)	-10.61***	(1.375)	0.472	(1.989)	0.0967	(0.0825)	78	0.443
EUR (%)	2.025	(1.600)	3.020***	(0.928)	0.00151	(0.0341)	78	0.237
GBP (%)	-0.447	(1.621)	3.264***	(0.940)	-0.0448	(0.0346)	78	0.172
YEN (%)	-2.362	(1.994)	5.512***	(1.156)	0.0494	(0.0425)	78	0.253
10-Year (bps)	40.69	(57.22)	73.39***	(27.23)	0.202	(1.009)	78	0.227
1-Year (bps)	11.93	(54.82)	32.64	(31.79)	-0.221	(1.169)	78	0.024
3-Month (bps)	28.35	(16.190)	3.456	(8.951)	0.467	(0.371)	78	0.219
1-Month (bps)	3.827	(18.92)	40.10	(27.36)	-0.624	(1.134)	78	0.028

Notes: Table shows responses of asset prices to monetary policy surprises. The sample period for before QE includes FOMC statements from January 1996 to November 25, 2008 (excluded) which is a total of 111 events. The sample period after QE includes FOMC statements from November 25, 2008 (included) to November 2017 which is a total of 78 events. Interest rates are in basis point, and the S&P 500 and exchange rates are in percentage change. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

When the dataset is divided into two, table-8 shows that with the exception of the equity market, all the responses of the financial markets to target surprise are insignificant after QE. This striking result proves that to adequately capture the impacts of monetary policy on financial markets, at least two factors in addition to Kuttner (2001)'s one factor (Target Factor) work, are needed. Therefore, these results offer further supporting evidence of Gürkaynak et al. (2005)'s work which suggests

that in addition to the target factor which is related to the fed fund target rate changes, the *future path factor* should be considered as a second factor of monetary policy.

Moreover, the response of 1-Year, 3-Month and 1-Month interest rate to the target surprise of monetary policy were significant *19 bsp*, *26 bsp*, and *41 bsp*, respectively before QE, while all have become statistically insignificant after QE. Their response to the path surprises is also insignificant. This suggests that after QE, there was no surprise action of the Fed for the short-term interest rate markets except the 10-Year interest rate which responds only to the path surprise after QE. In contrast, all exchange rate reactions to the path factor after the QE are significant and also, the magnitudes of these responses have increased. The response of S&P 500 to the path surprise have become insignificant. These results are consistent with Wu (2016) findings which showed that the exchange rates and 10-year Treasury yield are highly responsive, while the short-term interest rate and stock market have become less responsive after the crises. Therefore, it can be said that monetary policy becomes more transparent from a short-term perspective for the fixed income markets. However, after the QE the exchange rate markets are affected more by the monetary policy from the long-term perspective. Given that after the QE there are no significant reactions to the target surprise for the exchange rate markets while their response to the path surprise increased substantially. These findings are consistent with the argument that says the US Dollar has become more influential after the Fed's unconventional monetary policy. With those QE policies, the balance sheet of the Fed increased four times than before the pre-crisis period.

In summary, even though the exchange rate and long-term interest rate markets remain highly responsive to US monetary policy shocks throughout the entire sample, their responsiveness increased after QE. This implies that the Treasury yield changes in the US, induced by monetary policy surprise, are largely passed through to exchange rate and interest rate markets. Short-term interest rate markets exhibit less volatile responses to US monetary policy statements after the QE. At the zero lower bound, the traditional policy instrument – fed funds target rate – was no longer effective, so the Fed had to carry out unconventional monetary policies during this period to bring down long-term interest rates to stimulate the economy again. Thus, the long-term interest rates are still quite responsive to monetary policy shocks before and after QE, while short-term interest rates are largely constrained by zero lower bound policy. The recent financial crisis and unconventional monetary policy appear to seriously constrain the power of monetary policies to affect the short-term interest rate which was in the zero lower bound for more than seven years (2008-2015). On the whole, it can be said that the unconventional monetary policy increased the power of the dollar in exchange rate markets and the power of the US Treasury yield in the bond market. Moreover,

it was shown that in recession times the Fed does not surprise the financial markets even though the volatility is higher during these times as this is coming from other macroeconomic news and events. Therefore, further evidence has been provided in support of the argument in the previous chapter regarding the importance of using the intradaily window as a means of gaining a strong result, particularly in times of crise.

Table 9. The Responses of Financial Markets to FOMC Statements During the Non-Recession and the Recession Times

Non-Recession Times	From January 1996 to November 2017							
	Target	SE	Path	SE	Cons	SE	Obs	R-Sq
S&P 500 (%)	-2.437***	(0.672)	-1.074**	(0.470)	0.0161	(0.0388)	155	0.104
EURO (%)	-0.191	(0.856)	2.687***	(0.617)	0.0274	(0.0282)	155	0.112
GBP (%)	0.377	(0.798)	2.537***	(0.575)	-0.0204	(0.0263)	155	0.114
YEN (%)	0.467	(1.197)	2.677***	(0.862)	-0.000800	(0.0394)	155	0.060
10-Year IR (bps)	14.77	(14.34)	55.42***	(10.33)	-0.273	(0.472)	155	0.163
1-Year IR (bps)	-7.015	(17.12)	9.300	(12.34)	0.395	(0.563)	155	0.005
3-Month IR (bps)	13.70***	(3.930)	1.034	(2.674)	0.180	(0.223)	124	0.092
1-Month IR (bps)	9.516	(9.818)	1.282	(6.863)	-0.772	(0.568)	155	0.006
Recession Times	Dotcom & Mortgage							
	Target	SE	Path	SE	Cons	SE	Obs	R-Sq
S&P 500 (%)	-5.799	(7.957)	-4.552	(7.586)	-0.467	(0.581)	33	0.112
EURO (%)	0.402	(0.706)	-0.120	(0.726)	-0.0338	(0.103)	33	0.011
GBP (%)	-0.366	(0.924)	1.633	(1.309)	-0.0573	(0.0994)	33	0.049
YEN (%)	0.885	(0.895)	0.800	(1.267)	-0.0828	(0.0962)	33	0.060
10-Year IR (bps)	-4.176	(25.49)	49.42	(36.10)	-1.957	(2.741)	33	0.061
1-Year IR (bps)	22.50	(20.67)	-2.617	(29.27)	-4.684	(2.222)	33	0.040
3-Month IR (bps)	29.21	(21.48)	-5.365	(22.68)	-4.399	(3.221)	33	0.058
1-Month IR (bps)	48.59	(32.96)	-13.72	(34.81)	-3.888	(4.943)	33	0.068

Notes: Table shows responses of asset prices to monetary policy surprises. The sample period includes FOMC statements from January 1996 to November 25, 2008 (excluded) which is a total of 111 events. Interest rates are in bsp, and S&P 500 and exchange rates are in percentage change. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To see how the financial markets react to the monetary policy during recession times, the

equation-30 is estimated again by dividing the dataset into two parts, non-recession and recession times, respectively. So, the first panel of the Table-9 shows the regression estimation of the first group which is for responses of asset prices to monetary policy surprise during non-recession times which has 155 Fed announcements/events. Similarly, the second panel of the Table-9 is for responses to recession times that has 33 events. It is clear that during the recession times, there is neither the target (short term) nor the path policy (long-term) surprise for the financial markets. This suggests that in recession times the Fed becomes more transparent or the markets predict the Fed's actions well. Of note here is that when considering the volatility of financial asset prices during recession times it is clear that the volatility is higher than non-recession times. Even though the volatility increases during recession time, Table-9 indicates that the sources of this volatility are not the Fed policies but other news. Therefore, once again, it is suggested that using daily or wider windows during recession time will cause a mis-identification problem.

8 Conclusion

This research documented the effects of US monetary policy surprises on domestic financial assets and three main exchange rates. To discuss whether the response of financial asset prices to monetary policy surprises varies in conventional and unconventional times in terms of monetary policy implications in the US, this study compares the estimates of the pass-through of monetary policy shocks on financial assets before the QE with after QE. Further. it considers the different pattern of asset price reactions to US monetary policy communication in the recession and non-recession times with high-frequency data.

By using event study technique with the two proxies for monetary policy surprises which are the *target surprise* -the surprise change to the current target federal funds rate- and the *path surprise* -the revision to the expected path of future monetary policy, it concludes the evidence that Federal reserve communication affects financial markets significantly. Moreover, it has shown that these effects have a different pattern at different times. For example, the reactions to FOMC statements after QE are entirely different from before. Further, in parallel with Gürkaynak et al. (2005) and Hausman and Wongswan (2011) this study finds that different financial assets react to different factors of monetary policy surprises. For example, exchange rates and ten-year (long-term) interest rates respond only to the path surprises while stock exchange and short-term interest rates (three and one month) respond mainly to the target surprise. All significant responses volume increased after the QE. This shows that the Fed has become more influential on the financial market with the QE.

Moreover, it finds that, surprisingly, during recession times there are no monetary policy surprises for the financial markets. In other words, in recession times the Fed becomes more transparent regarding its policy stance.

This study examined the extent to which intradaily windows is different than daily window. We found that that the event study method with intradaily window is significantly different to the daily window, particularly at times of crises. This is consistent with expectation since a longer window would pick up other information, rather than only FOMC announcements. Therefore, the current study has examined the surprise components by considering different window sizes and different times over a period of almost 22 years with high frequency data and concludes that, to capture exact monetary policy surprise at least two monetary policy surprise components are needed, furthermore, in order to identify this surprise sharply, it is suggested that the intradaily data is used. Overall, these findings underline the critical importance of central bank communications in parallel with the findings of Hausman and Wongswan (2011) and Gürkaynak et al. (2005).

This research has thrown up many questions in need of further investigation. The effects of these surprise components on macroeconomic fundamentals and international financial markets is beyond the scope of this study; therefore, it is suggested that the association of these surprises are investigated in future research. For example, responses to numerous questions should be sought: how do international stock market prices respond to these surprises? Is there any difference in between advanced and non-advanced countries? Are there any international spilover macroeconomic effects of FOMC statements beyond the domestic impacts? Furthermore, surprises from the FOMC statement alone have been investigated therefore, this poses the questions, are there any surprise sources from other FOMC statement announcements for the financial markets such as FOMC minutes. These are the potential research questions for extending this study.

9 Derivation of the Target Surprise

$$ff^m_{d,t} = \mathbb{E}_{d,t}[r_{t+m}] + \eta^m_{d,t} \tag{31}$$

$$ff_{d_0-1,t} = \frac{d_0}{D_0} r_0 + \frac{D_0 - d_0}{D_0} \mathbb{E}_{d_0-1,t}(r_1) + \eta_{d_0-1,t} \tag{32}$$

where $ff_{d_0-1,t}$ is the closing-contract price on one-day before $(d_0 - 1)$ the FOMC announcement day (d_0) in month t. By evaluating the equations-32 one-day ahead which is at the end of day d_0, we can reach:

$$ff_{d_0,t} = \frac{d_0}{D_0} r_0 + \frac{D_0 - d_0}{D_0} (r_1) + \eta_{d_0,t} \tag{33}$$

where $ff_{d_0,t}$ is the contract price at the end of the FOMC announcement day in month t. Note that in both equations- 32 and 33, m is zero and so $ff_{d_0,t}$ equals $ff^0_{d_0,t}$ but for the simplicity we do not prefer to denote.

Differencing the equation-33 from the 32 :

$$ff_{d_0-1,t} - ff_{d_0,t} = \left(\frac{d_0}{D_0} r_0 - \frac{d_0}{D_0} r_0\right) + \frac{D_0 - d_0}{D_0} \Big(\mathbb{E}_{d_0-1,t}(r_1) - (r_1)\Big) + \Big(\eta_{d_0-1,t} - \eta_{d_0,t}\Big) \tag{34}$$

$$\Delta ff_{d_0,t} = \frac{D_0 - d_0}{D_0} \Big(\mathbb{E}_{d_0-1,t}(r_1) - (r_1)\Big) + \Delta\eta_{d_0,t} \tag{35}$$

where $\Delta ff_{d_0,t} \equiv ff_{d_0,t} - ff_{d_0-1,t}$ and $\Delta\eta_{d_0,t} \equiv \eta_{d_0,t} - \eta_{d_0-1,t}$

$$\Big(\mathbb{E}_{d_0-1,t}(r_1) - (r_1)\Big) = \Big(\Delta ff_{d_0,t} - \Delta\eta_{d_0,t}\Big) \frac{D_0}{D_0 - d_0} \tag{36}$$

where $\Delta\eta_{d_0,t} \equiv 0$ and the target surprise is

$$TS_{d_0,t} = \mathbb{E}_{d_0-1,t}(r_1) - (r_1) \tag{37}$$

simply;

$$TS_{d_0,t} = \frac{D_0}{D_0 - d_0} \Delta ff_{d_0,t} \tag{38}$$

where $\frac{D_0}{D_0 - d_0}$ is the *scaling factor* and $TS_{d_0,t}$ is the target surprise. Kuttner (2001) and Gürkay-

nak (2005) are followed in scaling for the concurrent month, $\Delta ff_{d_0,t}$ up by the ratio of the number of days in the month, D_0, over the number of days remaining after the meeting,$D_0 - d_0$. One problem might arise with this scaled measure in case of FOMC meetings that occur very late in the month. For example in the last seven days of the month, the scaling factor becomes very large at the end of the month for example, if the FOMC meeting takes place on December 30 then the scaling factor becomes 31 ($D_0 = 31$, $d_0 = 30$).

Thus, following Kuttner (2001) and Gürkaynak (2005) the unscaled change is used in the next-month fed funds futures contract to avoid multiplying by a very large scale factor in equation-12. In that case, $TS_{d_0,t} = \Delta ff^1_{d_0,t} = ff^1_{d_0,t} - ff^1_{d_0-1,t}$. Thus, no scaling is involved since the policy action affects the expected rates in the entire subsequent month contract.

In a simple terms, the target surprise daily is defined as $TS_d = \frac{D}{D-d}(ff_d - ff_{d-1})$ where d is the announcement day and $d-1$ is the one day before the announcement, ff is the 30-days Fed fund futures. Similarly, target surprise intradaily is defined as $TS_d = \frac{D}{D-d}(ff_{\tau+25} - ff_{\tau-15})$ where τ is the time of the announcement in day d. Hence $\tau + 25$ means 25 minutes after the announcement and $\tau - 15$ is 15 minutes before the announcement.

10 Derivation of the Path Surprise

Let ff denotes the futures contract rate for the month containing the second FOMC announcement. Then

$$ff_{d_0-1,t} = \frac{d_1}{D_1}\,\mathbb{E}_{d_0-1,t}[r_1] + \frac{D_1 - d_1}{D_1}\,\mathbb{E}_{d_0-1,t}[r_2] + \eta_{d_0-1,t} \tag{39}$$

where d_1 and D_1 are the day of that second FOMC announcement and the number of days in the month containing this second FOMC meeting. Similarly, $\eta_{d_0-1,t}$ reflects the risk premium as same as before. r_1 is the interest rate after the first FOMC meeting and r_2 is the interest rate after the second FOMC meeting. By evaluating the above equations ahead one day :

$$ff_{d_0,t} = \frac{d_1}{D_1}[r_1] + \frac{D_1 - d_1}{D_1}\,\mathbb{E}_{d_0,t}[r_2] + \eta_{d_0,t} \tag{40}$$

Differencing the equation-39 from the 40:

$$\Delta ff_{d_0,t} = \frac{d_1}{D_0}\Big(\mathbb{E}_{d_0-1,t}(r_1) - (r_1)\Big) + \frac{D_1 - d_1}{D_1}\Big(\mathbb{E}_{d_0-1,t}(r_2) - \mathbb{E}_{d_0,t}(r_2)\Big) \tag{41}$$

again same as equation-36 ; $\Delta ff_{d_0,t} \equiv ff_{d_0,t} - ff_{d_0-1,t}$ and $\Delta\eta_{d_0,t} \equiv 0$ and we have seen on

equation-37 that $TS_{d_0,t} = \mathbb{E}_{d_0-1,t}(r_1) - (r_1)$ and similarly the path surprise is

$$PS_{d_0,t} \equiv \mathbb{E}_{d_0-1,t}(r_2) - \mathbb{E}_{d_0,t}(r_2) \tag{42}$$

then we put $TS_{d_0,t}$ and $PS_{d_0,t}$ into equation-42

$$\Delta ff_{d_0,t} = \frac{d_1}{D_0} TS_{d_0,t} + \frac{D_1 - d_1}{D_1} PS_{d_0,t} \tag{43}$$

then we can reach the path surprise;

$$PS_{d_0,t} = \left(\Delta ff_{d_0,t} - \frac{d_1}{D_1} TS_{d_0,t}\right) \frac{D_1}{D_1 - d_1} \tag{44}$$

On the other hand, one can argue that a change in near-term (one-year) interest rates may be due to a surprise change in the target rate so Path surprise can also contain the effect of target surprise which violates our argument. Even though this argument is not persuasive since target surprise is proxied by one-month future contract while path surprise by one year Eurodollar which is entirely different maturity. However, to deal with this argument, we used two measures of the path surprise. Path Surprise I is the change in one-year-ahead Eurodollar interest rate futures in a one-day or 40 minutes window around the Fed events. To remove the effect of the target rate surprise from the change in the near-term interest rate, following Hausman and Wongswan (2011) and Gürkaynak et al. (2005) we defined Path Surprise II as the component of the change in one-year-ahead Eurodollar interest rate futures that is uncorrelated with the target surprise. In other words, we orthogonalised path surprises with respect to the target surprises to isolate the separate effects of target and long-term path surprises.

Thus, path surprise II represents news that financial agents have learned only from the FOMC announcement about the predicted future path of policy which is over and above what they have learned about the level of the target rate(Hausman and Wongswan, 2011). To derive path surprise II, following Hausman and Wongswan (2011) and Gürkaynak et al. (2005) it is run a regression of path surprise I on a constant and the target surprise. The innovation from this regression is Path Surprise II:

$$\text{Path Surprise}I_d = w_0 + w_1 * TS_d + PS_d^{II} \tag{45}$$

where PS_d^{II} (path surprise II) is the error term and uncorrelated with the target surprise. $PathSurpriseI_d = -.551 + .679 * TS_d + PS_d^{II}$ adjusted R-sq. is 0.23.

11 Additional Tables

Table 10. Summary Statistics for All FOMC Statements

Variable	Obs	Mean	Std. Dev.	Min	Max
All Times					
Policy Changes (bps)	188	-1.995	19.673	-75.00	50.00
Target Surprise(TS) intradaily(Int)	188	-1.16	8.15	-46.15	26.00
Target Surprise Daily(Day)	188	-1.16	10.16	-74.40	30.00
Difference of TS Int & Day (Absolute)	188	3.96	8.81	0.00	68.20
Path Surprise intradaily (bps)	188	-0.85	9.52	-53.59	50.53
Path Surprise Daily (bps)	188	-0.53	14.77	-72.94	96.25
Difference of PS Int & Day (Absolute)	188	6.22	10.03	0.00	105.25
Path Surprise 2 (PS2) intradaily (bps)	188	0.00	9.49	-53.44	50.74
Path Surprise 2 Daily (bps)	188	0.00	14.76	-72.47	96.72
Difference of PS2 Int & Day (Absolute)	188	6.30	10.32	0.05	107.36

Notes: This table shows basic statistics for proxies for monetary policy announcements surprises in daily and intradaily window length. The sample period includes all FOMC statements from January 3, 1996 through November 11, 2017, excluding the September 17, 2001 FOMC statement announcement.

Table-10 shows summary statistics path surprise II as well as other surprises. Path surprise II results are left unreported to save space, but as it can be seen from the table it has very similar statistics to the path surprise I.

Table 11. FOMC Statements and Minutes Announcements Dates and Times with Other Macroeconomic News

Dates	Time	Types	Other News
31/01/96	2:15 p.m.	FOMC Statement	PPI, Purchasing
26/03/96	11:39 a.m.	FOMC Statement	Consumer Confidence
29/03/96	2:15 p.m.	FOMC Minutes	U.S. Budget Deficit
21/05/96	2:15 p.m.	FOMC Statement	Auto Sales
24/05/96	2:15 p.m.	FOMC Minutes	International Trade
03/07/96	2:15 p.m.	FOMC Statement	Consumer Confidence
05/07/96	2:15 p.m.	FOMC Minutes	PPI
20/08/96	2:15 p.m.	FOMC Statement	Housing Starts
23/08/96	2:15 p.m.	FOMC Minutes	Auto Sales
24/09/96	2:15 p.m.	FOMC Statement	Consumer Confidence
27/09/96	2:15 p.m.	FOMC Minutes	NA
13/11/96	2:15 p.m.	FOMC Statement	Factory Orders
15/11/96	2:15 p.m.	FOMC Minutes	Housing Starts
17/12/96	2:15 p.m.	FOMC Statement	New Home Sales
20/12/96	2:15 p.m.	FOMC Minutes	NA
05/02/97	2:15 p.m.	FOMC Statement	CPI
06/02/97	2:12 p.m.	FOMC Minutes	NA
25/03/97	2:15 p.m.	FOMC Statement	Consumer Confidence
27/03/97	2:15 p.m.	FOMC Minutes	Housing Starts
20/05/97	2:15 p.m.	FOMC Statement	Auto Sales
22/05/97	2:15 p.m.	FOMC Minutes	CPI, International Trade
02/07/97	2:15 p.m.	FOMC Statement	Consumer Confidence
03/07/97	3:15 p.m.	FOMC Minutes	PPI
19/08/97	2:15 p.m.	FOMC Statement	CPI
21/08/97	2:15 p.m.	FOMC Minutes	NA
30/09/97	2:12 p.m.	FOMC Statement	Auto Sales
02/10/97	2:12 p.m.	FOMC Minutes	Consumer Confidence
12/11/97	2:11 p.m.	FOMC Statement	Housing Starts
13/11/97	2:15 p.m.	FOMC Minutes	Leading Indicators
16/12/97	2:15 p.m.	FOMC Statement	NA
18/12/97	2:12 p.m.	FOMC Minutes	Leading Indicators
04/02/98	2:15 p.m.	FOMC Statement	Industrial Production
05/02/98	2:15 p.m.	FOMC Minutes	U.S. Budget Deficit
31/03/98	2:15 p.m.	FOMC Statement	New Home Sales
02/04/98	2:15 p.m.	FOMC Minutes	International Trade

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Table 11 – continued from previous page

Dates	Time	Types	Other News
19/05/98	2:15 p.m.	FOMC Statement	CPI
21/05/98	2:15 p.m.	FOMC Minutes	Durable Goods Orders
01/07/98	2:15 p.m.	FOMC Statement	
02/07/98	2:12 p.m.	FOMC Minutes	New Home Sales
18/08/98	2:12 p.m.	FOMC Statement	Business Inventories
20/08/98	2:15 p.m.	FOMC Minutes	International Trade
29/09/98	1:13 p.m.	FOMC Statement	NA
01/10/98	2:15 p.m.	FOMC Minutes	GDP and NIPAs
15/10/98	2:15 p.m.	FOMC Statement	U.S. Budget Deficit
17/11/98	10:54 a.m.	FOMC Statement	International Trade
19/11/98	2:15 p.m.	FOMC Minutes	NA
22/12/98	2:12 p.m.	FOMC Statement	NA
23/12/98	2:15 p.m.	FOMC Minutes	NA
03/02/99	8:20 a.m.	FOMC Statement	NA
04/02/99	2:15 p.m.	FOMC Minutes	NA
30/03/99	2:20 p.m.	FOMC Statement	NA
01/04/99	2:15 p.m.	FOMC Minutes	NA
18/05/99	2:15 p.m.	FOMC Statement	GDP and NIPAs
20/05/99	2:15 p.m.	FOMC Minutes	International Trade
30/06/99	2:15 p.m.	FOMC Statement	NA
01/07/99	2:15 p.m.	FOMC Minutes	New Home Sales
24/08/99	2:15 p.m.	FOMC Statement	Retail Sales
26/08/99	2:15 p.m.	FOMC Minutes	Consumer Confidence
05/10/99	2:15 p.m.	FOMC Statement	NA
07/10/99	2:15 p.m.	FOMC Minutes	NA
16/11/99	2:15 p.m.	FOMC Statement	NA
18/11/99	2:15 p.m.	FOMC Minutes	Home Sales
21/12/99	2:15 p.m.	FOMC Statement	NA
23/12/99	2:15 p.m.	FOMC Minutes	Home Sales
02/02/00	2:15 p.m.	FOMC Statement	NA
03/02/00	2:15 p.m.	FOMC Minutes	CPI
21/03/00	2:15 p.m.	FOMC Statement	Consumer Confidence
23/03/00	2:15 p.m.	FOMC Minutes	NA
16/05/00	2:15 p.m.	FOMC Statement	New Home Sales
18/05/00	2:15 p.m.	FOMC Minutes	Housing Starts
28/06/00	2:15 p.m.	FOMC Statement	Factory Orders
29/06/00	2:15 p.m.	FOMC Minutes	NA

Continued on next page...

Table 11 – continued from previous page

Dates	Time	Types	Other News
22/08/00	2:15 p.m.	FOMC Statement	NA
24/08/00	2:15 p.m.	FOMC Minutes	Housing Starts
03/10/00	2:15 p.m.	FOMC Statement	U.S. Budget
05/10/00	2:15 p.m.	FOMC Minutes	International Trade
15/11/00	2:00 p.m.	FOMC Statement	Auto Sales
16/11/00	2:15 p.m.	FOMC Minutes	NA
19/12/00	2:00 p.m.	FOMC Statement	Factory Orders, CPI
21/12/00	2:15 p.m.	FOMC Minutes	PPI
03/01/01	2:00 p.m.	FOMC Statement	NA
04/01/01	2:15 p.m.	FOMC Minutes	Auto Sales
31/01/01	2:00 p.m.	FOMC Statement	Existing Home Sales
20/03/01	2:15 p.m.	FOMC Statement	PCE
22/03/01	2:00 p.m.	FOMC Minutes	Leading Indicators
18/04/01	2:15 p.m.	FOMC Statement	NA
19/04/01	2:00 p.m.	FOMC Minutes	Consumer Confidence
15/05/01	2:15 p.m.	FOMC Statement	Housing Starts
27/06/01	2:00 p.m.	FOMC Statement	NA
28/06/01	2:15 p.m.	FOMC Minutes	Construction Spending
21/08/01	2:00 p.m.	FOMC Statement	NA
23/08/01	2:15 p.m.	FOMC Minutes	Retail Sales
20/09/01	2:15 p.m.	FOMC Minutes	Consumer Confidence
02/10/01	2:00 p.m.	FOMC Statement	Leading Indicators
06/11/01	2:15 p.m.	FOMC Statement	Consumer Confidence
08/11/01	2:00 p.m.	FOMC Minutes	PPI, Housing Starts
11/12/01	2:15 p.m.	FOMC Statement	U.S. Budget Deficit
13/12/01	2:00 p.m.	FOMC Minutes	PPI, Housing Starts
30/01/02	2:15 p.m.	FOMC Statement	GDP and NIPAs,
31/01/02	2:00 p.m.	FOMC Minutes	Leading Indicators
19/03/02	2:15 p.m.	FOMC Statement	NA
21/03/02	2:00 p.m.	FOMC Minutes	Consumer Confidence
07/05/02	2:15 p.m.	FOMC Statement	NA
09/05/02	2:00 p.m.	FOMC Minutes	NA
26/06/02	2:15 p.m.	FOMC Statement	Existing Home Sales
27/06/02	2:00 p.m.	FOMC Minutes	NA
13/08/02	2:15 p.m.	FOMC Statement	U.S. Budget Deficit
15/08/02	2:00 p.m.	FOMC Minutes	Construction Spending
24/09/02	2:15 p.m.	FOMC Statement	GDP and NIPAs

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Dates	Time	Types	Other News
26/09/02	2:00 p.m.	FOMC Minutes	CPI
06/11/02	2:15 p.m.	FOMC Statement	NA
07/11/02	2:00 p.m.	FOMC Minutes	U.S. Budget Deficit
10/12/02	2:15 p.m.	FOMC Statement	NA
12/12/02	2:00 p.m.	FOMC Minutes	NA
29/01/03	2:15 p.m.	FOMC Statement	GDP and NIPAs
30/01/03	2:00 p.m.	FOMC Minutes	Leading Indicators
18/03/03	2:15 p.m.	FOMC Statement	Productivity
20/03/03	2:00 p.m.	FOMC Minutes	U.S. Budget Deficit
06/05/03	2:00 p.m.	FOMC Statement	Michigan Sentiment
08/05/03	2:00 p.m.	FOMC Minutes	Michigan Sentiment
25/06/03	2:00 p.m.	FOMC Statement	Consumer Confidence
26/06/03	2:15 p.m.	FOMC Minutes	PPI
12/08/03	2:00 p.m.	FOMC Statement	NA
14/08/03	2:15 p.m.	FOMC Minutes	GDP
16/09/03	2:00 p.m.	FOMC Statement	Housing Starts
18/09/03	2:15 p.m.	FOMC Minutes	NA
28/10/03	2:00 p.m.	FOMC Statement	Construction Spending
30/10/03	2:00 p.m.	FOMC Minutes	NA
09/12/03	2:15 p.m.	FOMC Statement	GDP and NIPAs
11/12/03	2:00 p.m.	FOMC Minutes	CPI, Housing Starts
28/01/04	2:00 p.m.	FOMC Statement	NA
29/01/04	2:15 p.m.	FOMC Minutes	PPI, Housing Starts
16/03/04	2:00 p.m.	FOMC Statement	NA
18/03/04	2:15 p.m.	FOMC Minutes	ECI, GDP and NIPAs
04/05/04	2:00 p.m.	FOMC Statement	Employment Report
06/05/04	2:00 p.m.	FOMC Minutes	NA
30/06/04	2:15 p.m.	FOMC Statement	New Home Sales
01/07/04	2:00 p.m.	FOMC Minutes	CPI, Industrial Production
10/08/04	2:15 p.m.	FOMC Statement	ISM Survey
12/08/04	2:00 p.m.	FOMC Minutes	Consumer Confidence
21/09/04	2:15 p.m.	FOMC Statement	CPI
23/09/04	10:00 a.m.	FOMC Minutes	PCE
10/11/04	2:00 p.m.	FOMC Statement	NA
14/12/04	2:15 p.m.	FOMC Statement	NA
16/12/04	2:00 p.m.	FOMC Minutes	CPI, Housing Starts
04/01/05	2:15 p.m.	FOMC Minutes	CPI, Housing Starts

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Table 11 – continued from previous page

Dates	Time	Types	Other News
02/02/05	2:00 p.m.	FOMC Statement	NA
23/02/05	2:15 p.m.	FOMC Minutes	NA
22/03/05	2:00 p.m.	FOMC Statement	Industrial Production
12/04/05	2:15 p.m.	FOMC Minutes	CPI
03/05/05	2:00 p.m.	FOMC Statement	NA
24/05/05	2:15 p.m.	FOMC Minutes	GDP and NIPAs
30/06/05	2:00 p.m.	FOMC Statement	NA
21/07/05	2:15 p.m.	FOMC Minutes	New Home Sales
09/08/05	2:00 p.m.	FOMC Statement	CPI
30/08/05	2:15 p.m.	FOMC Minutes	International Trade
20/09/05	2:00 p.m.	FOMC Statement	Productivity
11/10/05	2:15 p.m.	FOMC Minutes	NA
01/11/05	2:00 p.m.	FOMC Statement	Retail Sales
22/11/05	2:15 p.m.	FOMC Minutes	ISM Survey
13/12/05	2:00 p.m.	FOMC Statement	GDP
03/01/06	2:15 p.m.	FOMC Minutes	CPI, Housing Starts
31/01/06	2:00 p.m.	FOMC Statement	ISM Survey
21/02/06	2:15 p.m.	FOMC Minutes	New Home Sales
28/03/06	2:00 p.m.	FOMC Statement	U.S. Budget Deficit
18/04/06	2:15 p.m.	FOMC Minutes	Housing Starts
10/05/06	2:00 p.m.	FOMC Statement	NA
31/05/06	2:15 p.m.	FOMC Minutes	NA
29/06/06	12:00 p.m.	FOMC Statement	NA
08/08/06	2:00 p.m.	FOMC Statement	CPI
29/08/06	2:15 p.m.	FOMC Minutes	New Home Sales
20/09/06	2:00 p.m.	FOMC Statement	Retail Sales
11/10/06	2:15 p.m.	FOMC Minutes	Productivity
25/10/06	10:00 a.m.	FOMC Statement	NA
15/11/06	2:00 p.m.	FOMC Minutes	Consumer Confidence
12/12/06	2:15 p.m.	FOMC Statement	Housing Starts
03/01/07	2:00 p.m.	FOMC Minutes	NA
31/01/07	2:15 p.m.	FOMC Statement	Factory Orders
21/02/07	2:00 p.m.	FOMC Minutes	GDP
21/03/07	2:15 p.m.	FOMC Statement	Retail Sales, PPI
11/04/07	2:00 p.m.	FOMC Minutes	Auto Sales
09/05/07	2:15 p.m.	FOMC Statement	New Home Sales
30/05/07	2:00 p.m.	FOMC Minutes	PPI, Housing Starts

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Table 11 – continued from previous page

Dates	Time	Types	Other News
28/06/07	2:15 p.m.	FOMC Statement	NA
19/07/07	2:00 p.m.	FOMC Minutes	ISM Survey
07/08/07	12:30 p.m.	FOMC Statement	Durable Goods Orders
28/08/07	2:00 p.m.	FOMC Minutes	NA
18/09/07	12:30 p.m.	FOMC Statement	NA
09/10/07	2:00 p.m.	FOMC Minutes	International Trade
31/10/07	12:30 p.m.	FOMC Statement	NA
20/11/07	2:00 p.m.	FOMC Minutes	Consumer Confidence
11/12/07	2:15 p.m.	FOMC Statement	Existing Home Sales
02/01/08	2:00 p.m.	FOMC Minutes	NA
22/01/08	12:30 p.m.	FOMC Statement	NA
30/01/08	2:00 p.m.	FOMC Statement	GDP and NIPAs
20/02/08	2:15 p.m.	FOMC Minutes	Retail Sales
18/03/08	2:00 p.m.	FOMC Statement	Construction Spending
08/04/08	12:30 p.m.	FOMC Minutes	NA
30/04/08	2:00 p.m.	FOMC Statement	Industrial Production
21/05/08	2:15 p.m.	FOMC Minutes	Retail Sales
25/06/08	2:00 p.m.	FOMC Statement	Factory Orders, Auto Sales
16/07/08	12:30 p.m.	FOMC Minutes	Durable Goods Orders
05/08/08	2:00 p.m.	FOMC Statement	Industrial Production
26/08/08	12:30 p.m.	FOMC Minutes	NA
16/09/08	2:00 p.m.	FOMC Statement	International Trade
19/09/08	2:15 p.m.	FOMC Statement	Construction Spending
29/09/08	10:00 p.m.	FOMC Statement	Existing Home Sales
07/10/08	12:30 p.m.	FOMC Statement	PPI, U.S. Budget Deficit
29/10/08	2:00 p.m.	FOMC Statement	Factory Orders
19/11/08	2:15 p.m.	FOMC Minutes	New Home Sales
25/11/08	2:00 p.m.	FOMC Statement	Retail Sales, PPI
01/12/08	12:30 p.m.	FOMC Statement	U.S. Budget Deficit
16/12/08	2:00 p.m.	FOMC Statement	Auto Sales
06/01/09	2:00 p.m.	FOMC Minutes	GDP
28/01/09	2:15 p.m.	FOMC Statement	PPI, Housing Starts
18/02/09	2:00 p.m.	FOMC Minutes	NA
18/03/09	2:15 p.m.	FOMC Statement	NA
08/04/09	2:00 p.m.	FOMC Minutes	PMI, Home Sales,
29/04/09	2:15 p.m.	FOMC Statement	GDP
20/05/09	2:00 p.m.	FOMC Minutes	PMI, Fed Testimony

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Dates	Time	Types	Other News
24/06/09	2:15 p.m.	FOMC Statement	New Home Sales
15/07/09	2:00 p.m.	FOMC Minutes	Core CPI
12/08/09	2:15 p.m.	FOMC Statement	NA
02/09/09	2:00 p.m.	FOMC Minutes	NA
23/09/09	2:15 p.m.	FOMC Statement	NA
14/10/09	2:00 p.m.	FOMC Minutes	Retail Sale
04/11/09	2:15 p.m.	FOMC Statement	PMI, Nonfarm
24/11/09	2:00 p.m.	FOMC Minutes	GDP, Consumer Confidence
16/12/09	2:15 p.m.	FOMC Statement	Core CPI
06/01/10	2:00 p.m.	FOMC Minutes	PMI
27/01/10	2:15 p.m.	FOMC Statement	New Home Sales
17/02/10	2:00 p.m.	FOMC Minutes	NA
16/03/10	2:15 p.m.	FOMC Statement	NA
06/04/10	2:00 p.m.	FOMC Minutes	NA
28/04/10	2:15 p.m.	FOMC Statement	NA
19/05/10	2:00 p.m.	FOMC Minutes	Core CPI
23/06/10	2:15 p.m.	FOMC Statement	New Home Sales
14/07/10	2:00 p.m.	FOMC Minutes	Retail Sales
10/08/10	2:15 p.m.	FOMC Statement	NA
27/08/10	2:15 p.m.	FOMC Statement	GDP
31/08/10	2:00 p.m.	FOMC Minutes	Consumer Confidence
21/09/10	2:15 p.m.	FOMC Statement	NA
12/10/10	2:00 p.m.	FOMC Minutes	NA
15/10/10	2:15 p.m.	FOMC Statement	Core CPI and Retail
03/11/10	2:15 p.m.	FOMC Statement	Nonfarm, PMI,
23/11/10	2:00 p.m.	FOMC Minutes	GDP, Home Sales
14/12/10	2:15 p.m.	FOMC Statement	PPI, Retail Sates
04/01/11	2:00 p.m.	FOMC Minutes	NA
26/01/11	2:15 p.m.	FOMC Statement	New Home Sales
16/02/11	2:00 p.m.	FOMC Minutes	PPI
15/03/11	2:15 p.m.	FOMC Statement	NA
05/04/11	2:00 p.m.	FOMC Minutes	PMI
27/04/11	2:15 p.m.	FOMC Statement	NA
18/05/11	2:00 p.m.	FOMC Minutes	NA
22/06/11	2:15 p.m.	FOMC Statement	NA
12/07/11	2:00 p.m.	FOMC Minutes	NA
09/08/11	2:15 p.m.	FOMC Statement	NA

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Dates	Time	Types	Other News
26/08/11	2:15 p.m.	FOMC Statement	GDP
30/08/11	2:00 p.m.	FOMC Minutes	Consumer Confidence
21/09/11	2:15 p.m.	FOMC Statement	Home Sales
12/10/11	2:00 p.m.	FOMC Minutes	NA
02/11/11	2:15 p.m.	FOMC Statement	Nonfarm
22/11/11	2:00 p.m.	FOMC Minutes	GDP
13/12/11	2:15 p.m.	FOMC Statement	Retail Sales
03/01/12	2:00 p.m.	FOMC Minutes	PMI
25/01/12	2:15 p.m.	FOMC Statement	Home Sales
15/02/12	2:00 p.m.	FOMC Minutes	NA
13/03/12	2:15 p.m.	FOMC Statement	Retail Sales
03/04/12	2:00 p.m.	FOMC Minutes	Nonfarm, PMI
25/04/12	2:15 p.m.	FOMC Statement	NA
16/05/12	2:00 p.m.	FOMC Minutes	Cpi, Retail Sales
20/06/12	2:15 p.m.	FOMC Statement	NA
11/07/12	2:00 p.m.	FOMC Minutes	NA
01/08/12	2:15 p.m.	FOMC Statement	Job Openings,PMI
22/08/12	2:00 p.m.	FOMC Minutes	Home Sales
31/08/12	2:00 p.m.	FOMC Statement	NA
13/09/12	2:15 p.m.	FOMC Statement	PPI
04/10/12	2:00 p.m.	FOMC Minutes	NA
24/10/12	2:15 p.m.	FOMC Statement	New Home Sales
14/11/12	2:00 p.m.	FOMC Minutes	PPI, Retail Sates
12/12/12	2:15 p.m.	FOMC Statement	NA
03/01/13	2:00 p.m.	FOMC Minutes	Nonfarm
30/01/13	2:15 p.m.	FOMC Statement	GDP
20/02/13	2:00 p.m.	FOMC Minutes	PPI
20/03/13	2:15 p.m.	FOMC Statement	NA
10/04/13	2:00 p.m.	FOMC Minutes	NA
01/05/13	2:15 p.m.	FOMC Statement	Job Openings,PMI
22/05/13	2:00 p.m.	FOMC Minutes	Home Sales
19/06/13	2:15 p.m.	FOMC Statement	NA
10/07/13	2:00 p.m.	FOMC Minutes	NA
31/07/13	2:15 p.m.	FOMC Statement	GDP
21/08/13	2:00 p.m.	FOMC Minutes	Home Sales
18/09/13	2:15 p.m.	FOMC Statement	NA
09/10/13	2:00 p.m.	FOMC Minutes	NA

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Dates	Time	Types	Other News
30/10/13	2:15 p.m.	FOMC Statement	CPI
20/11/13	2:00 p.m.	FOMC Minutes	Retail, Home Sales
18/12/13	2:15 p.m.	FOMC Statement	NA
08/01/14	2:00 p.m.	FOMC Minutes	NA
29/01/14	2:15 p.m.	FOMC Statement	NA
19/02/14	2:00 p.m.	FOMC Minutes	PPI
19/03/14	2:15 p.m.	FOMC Statement	NA
09/04/14	2:00 p.m.	FOMC Minutes	NA
30/04/14	2:15 p.m.	FOMC Statement	GDP
21/05/14	2:00 p.m.	FOMC Minutes	NA
18/06/14	2:15 p.m.	FOMC Statement	NA
09/07/14	2:00 p.m.	FOMC Minutes	NA
30/07/14	2:15 p.m.	FOMC Statement	GDP
20/08/14	2:00 p.m.	FOMC Minutes	NA
17/09/14	2:15 p.m.	FOMC Statement	CPI
08/10/14	2:00 p.m.	FOMC Minutes	NA
29/10/14	2:15 p.m.	FOMC Statement	NA
19/11/14	2:00 p.m.	FOMC Minutes	Building Permits
17/12/14	2:15 p.m.	FOMC Statement	CPI
07/01/15	2:00 p.m.	FOMC Minutes	NA
28/01/15	2:15 p.m.	FOMC Statement	NA
18/02/15	2:00 p.m.	FOMC Minutes	Building Permits,PPI
18/03/15	2:15 p.m.	FOMC Statement	NA
08/04/15	2:00 p.m.	FOMC Minutes	NA
29/04/15	2:15 p.m.	FOMC Statement	GDP
20/05/15	2:00 p.m.	FOMC Minutes	NA
17/06/15	2:15 p.m.	FOMC Statement	NA
08/07/15	2:00 p.m.	FOMC Minutes	NA
29/07/15	2:15 p.m.	FOMC Statement	Home Sales
19/08/15	2:00 p.m.	FOMC Minutes	CPI
17/09/15	2:15 p.m.	FOMC Statement	Building Permits
08/10/15	2:00 p.m.	FOMC Minutes	NA
28/10/15	2:15 p.m.	FOMC Statement	NA
18/11/15	2:00 p.m.	FOMC Minutes	Building Permits
16/12/15	2:15 p.m.	FOMC Statement	Building Permits
06/01/16	2:00 p.m.	FOMC Minutes	PMI
27/01/16	2:15 p.m.	FOMC Statement	Home Sales

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Dates	Time	Types	Other News
17/02/16	2:00 p.m.	FOMC Minutes	PMI
16/03/16	2:15 p.m.	FOMC Statement	CPI
06/04/16	2:00 p.m.	FOMC Minutes	NA
27/04/16	2:15 p.m.	FOMC Statement	Home Sales
18/05/16	2:00 p.m.	FOMC Minutes	NA
15/06/16	2:15 p.m.	FOMC Statement	PPI
06/07/16	2:00 p.m.	FOMC Minutes	PMI
27/07/16	2:15 p.m.	FOMC Statement	Home Sales
17/08/16	2:00 p.m.	FOMC Minutes	NA
21/09/16	2:15 p.m.	FOMC Statement	NA
12/10/16	2:00 p.m.	FOMC Minutes	Job Openings
02/11/16	2:15 p.m.	FOMC Statement	NA
23/11/16	2:00 p.m.	FOMC Minutes	Home Sales
14/12/16	2:15 p.m.	FOMC Statement	PPI, Retail Sates
04/01/17	2:00 p.m.	FOMC Minutes	NA
01/02/17	2:15 p.m.	FOMC Statement	PMI
22/02/17	2:00 p.m.	FOMC Minutes	Home Sales
15/03/17	2:15 p.m.	FOMC Statement	CPI, Retail Sales
05/04/17	2:00 p.m.	FOMC Minutes	PMI
03/05/17	2:15 p.m.	FOMC Statement	PMI
24/05/17	2:00 p.m.	FOMC Minutes	Home Sales
14/06/17	2:15 p.m.	FOMC Statement	CPI,Retail Sales
05/07/17	2:00 p.m.	FOMC Minutes	NA
26/07/17	2:15 p.m.	FOMC Statement	Home Sales
16/08/17	2:00 p.m.	FOMC Minutes	Building Permits
20/09/17	2:15 p.m.	FOMC Statement	Home Sales
11/10/17	2:00 p.m.	FOMC Minutes	Job Openings
01/11/17	2:15 p.m.	FOMC Statement	PMI

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