Does FOMC news increase global FX trading?

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ABSTRACT

Does global currency volume increase on Federal Open Market Committee (FOMC) days? To test hypotheses of abnormal currency volume on FOMC days, a new data set from the Continuous Linked Settlement (CLS) Bank is used. The CLS measure captures more than half of the global trading volume in foreign exchange (FX) markets. The evidence shows that FX trading volume increases about 5% in the spot and the spot-next market following FOMC deliberations. The novelty of this result is that the aggregated CLS data controls for responses in various derivatives markets: a feature that existing studies based on intradaily data for specific trading platforms do not consider.

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1. Introduction

Does global currency volume increase on Federal Open Market Committee (FOMC) days? Previous empirical research has focused on the price response to FOMC news. Ahn and Melvin (2007), Andersen et al. (2003), Faust et al. (2006), and Hausman and Wongswan (2006) show that foreign exchange (FX) quotes respond in a matter of minutes to public information (news) released by the FOMC.[1] Despite the vast empirical evidence on FX price responses to monetary policy shocks, little is known as to how global currency volume behaves in the face of FOMC days. We set out to do this.

We present evidence of global currency volume following FOMC meetings and examine the role of monetary shocks on FX volume. In contrast to many microstructure studies that examine the financial market response to macroeconomic releases, this study focuses primarily on FOMC announcement effects. First, FOMC days are acknowledged to be important events.[2]

[1] Other recent contributions of FX price responses to FOMC news include Chaboud et al. (2004), Evans and Lyons (2005), Fatum and Scholnick (2008), Faust et al. (2006), and Simpson et al. (2005). See also recent studies by Bernanke and Kuttner (2005), Ehrmann and Fratzscher (2004), Gürkaynak et al. (2005), and Kuttner (2001) that examine the price response of various financial assets to FOMC announcements.

[2] Andersen et al. (2003), Chaboud et al. (2004), Chaboud et al. (2008), and others find that FOMC days stand out when comparing the relative FX response strength of different

Currency traders worldwide monitor FOMC meetings for information of imminent changes in the federal funds rate target, because interest rates are a fundamental determinant of exchange rates. Second, to capture the surprise component through financial variables, a monetary shock measure is needed that has a time window of 30 minutes or less.[3] As is discussed in greater detail below such financial measures are readily available for FOMC events but not for a range of macroeconomic releases.

Identifying global FX trading on FOMC days contributes to the expanding literature on FX volume in two ways. The first issue concerns deterministic volume responses to scheduled announcements. Chaboud et al. (2008) show that FX volume jumps even when FOMC announcements are in line with market expectations. Chaboud et al. (2008) and others attribute the volume response pattern to wait-and-see behavior on the part of FX traders. This result for the spot market says that scheduled FOMC days generate deterministic jumps in FX trading. The next step is to examine whether

sets of macroeconomic announcements.

[3]Chaboud et al. (2008) and others rely on MMS survey data. The advantage of MMS survey data is that it covers a range of scheduled macroeconomic releases, however the major drawback lies in the precision of the survey information. The information lag is measured in days rather than minutes (as is Kuttner, 2001).

such timing effects on FOMC days hold for a broader measure of global FX volume as well. We want to understand whether deterministic volume effects in the derivatives (swap and forward) market move in tandem to volume responses in the spot market so that the aggregate FX volume effect is not mitigated. Following the terminology of Andersen et al. (2003) for asset prices, we call the deterministic FX volume response on FOMC days the announcement timing effect.

A second issue regarding FOMC days and FX volume is communication. Central bankers worry about how they communicate with financial markets. Blinder et al. (2008) argue that the objective of central bank communication is either to reduce market noise or to augment market volatility. Central bank communication is a form of public information. A distinction is often made in the microstructure literature between public and private information. While public information such as central bank communication does not require trading to impact prices, private information that is available to a select group of market participants affects prices only through trading. To test these claims of a non-volume response to central bank communication that are separate from the announcement timing hypothesis, we use the Kuttner

(2001) shock measure.[4] Numerous papers examine the asset price response to the Kuttner (2001) shock that is perceived as the best proxy capturing the FOMC shock, however we are the first to link this shock measure with FX volume. More specifically, we want to understand how the magnitude of the Kuttner shock influences FX volume. Again using the terminology of Andersen et al. (2003), we call this FX volume response the announcement surprise effect.

A difficult hurdle for studies on global FX trading activity is measurement. The FX market is borderless, spans different products, and many other market microstructure aspects such as multiple trading platforms and different trading venues (i.e., brokerage or interdealer market). Until now, high frequency studies such as Berger et al. (2008), Berger et al. (2009), Cai et al. (2008), Chaboud et al. (2008), Chen and Gau (2010), and Evans and Lyons (2005, 2008) examine FX volume behavior only for specific trading

[4]The existing microstructure literature, say Berger et al. (2008), Berger et al. (2009), Evans (2002) and Evans and Lyons (2008), based on intradaily data uses order flow to examine how the asymmetry of supply and demand influences prices. These studies have also considered trading volume but do not find a significant relationship between volume and price determination. Our measure of global FX activity has no comparable proxy of global order flow and is therefore unable to examine the issue of price determination.

platforms or select markets. Alternatively, earlier studies such as Melvin and Yin (2003) use price fluctuations as a crude measure of FX volume. Neither of these methods are representative of global FX volume in the true sense.

Our solution to the measurement problem of global FX trading activity relies on settlement information from the Continuous Linked Settlement (CLS) Bank in New York. The main advantage of CLS volume data is that decentralized FX trades are centrally settled in New York. The data's breadth captures volume activity in the spot, swap, and forward markets.[5] Since its introduction in September 2002, CLS Bank captures more than half of the FX volume across major currencies at high frequencies.

The new evidence shows a significant increase in FX volume linked to the spot and the spot-next market for the largest currencies on FOMC days. The empirical results also find that irrespective of the price change in the exchange rate or FOMC news type, CLS currency volume always increases. The novelty of this result is that CLS data controls for responses in different derivatives markets: a feature that existing studies based on intradaily data

[5] Average daily values for December 2007 were USD 611 billion for the spot market, USD 710 billion for the FX swap market, and USD 139 billion for the forward market. Although they do not influence our analysis, CLS also covers options exercises, non deliverable forwards, and credit derivatives after December 2007.

for specific trading platforms are unable or do not do.

The paper is organized as follows: Section 2 discusses measurement issues of global FX volume and presents the CLS data. Section 3 motivates the empirical setup. The same section includes a discussion of the empirical hypotheses, empirical estimation, and hypothesis testing. Section 4 presents the empirical evidence for currency volume and FOMC days. Section 5 offers conclusions that emphasize the importance of capturing the FX volume response to heavy monitored events in global financial markets.

2. Data issues

This section addresses measurement issues of global FX volume. First, the advantages and limits of a settlement-based definition of FX turnover are discussed. Thereafter, we document the main properties of CLS currency volume.[6]

2.1. CLS data and FX volume

A serious drawback of empirical studies on FX volume is measurement.[7] Data

[6]The terms FX volume and FX trading activity are used interchangeably in this paper. CLS data refer to currency volume and not number of transactions. The latter is often used as a measure of FX volume.

[7]This section relies heavily on McPortland (2006), Millar and Northcott (2002), and

availability is problematic because the FX market is highly decentralized in terms of location, currency product, and trading platforms. Aggregation is further complicated because FX transactions span different national and legal jurisdictions, time zones, and domestic payments systems.

Previous empirical studies of international finance use three broad measures of trading volume. Each has its drawbacks. The first is the BIS Triennial Survey of global volume in traditional product markets (i.e., spot, forward, and swap markets). The three-year frequency and the evolving coverage of the BIS survey on currency volume, however, represent a serious limitation for empirical research studying the dynamics of global FX volume. A second method used by Goodhart and Figliuoli (1991), Melvin and Peiers Melvin (2003), and Melvin and Yin (2003) proxies FX volume with price movements, i.e., with indicative quotes or transactions data for specific currency markets. The intuition, which Harris (1987) and others have found for equity markets, is that trading volume is positively correlated with the square of price changes.[8] Although favored by empirical researchers because

Saywer (2004). They provide further institutional discussions from the perspective of payments systems and infrastructure.

[8]In a similar manner, Müller et al. (1990) use the average number of ticks (number of quotes) as a proxy for worldwide trading activity.

of its high frequency, FX volume remains a latent variable and is market specific. A third approach by Berger et al. (2008), Berger et al. (2009), Cai et al. (2008), Chaboud and LeBaron (2001), and Chaboud et al. (2004) measures transaction volume for select markets and trading platforms. While this latter approach represents a step forward in capturing FX volume at high frequencies, it is still product specific.[9]

Observing market activity at the back-end is a way out of the coverage-frequency dilemma. Rather than measuring currency volume at transaction time, an alternative measure is at settlement time. The main advantage of such a back-end measure of FX volume is that roughly 55% of the currency transactions in traditional markets are settled in a centralized manner through the CLS Bank in New York.[10] Moreover, CLS coverage includes FX volume from customer dealers, brokered dealers, and direct dealers. CLS

[9]The BIS surveys, for example, mention repeatedly that the growth in the spot market does not move in tandem with the swap market. Table B.1 in BIS (2005) shows that the smaller currency markets, spot and outright forwards, grew faster between 2001 and 2004 (at 60%) than the larger swap market (40%).

[10]The figure is from table 8 of the CPSS (2007) survey. This survey measures CLS coverage at a single point in time in 2006. It is unlikely that coverage was as complete at sample begin.

volume data are available at high frequencies and ensure a representative coverage of global FX volume.

FX transactions always have a trade date and a settlement date. The former is the date when both parties come together and define the terms of the trade. The latter, also known as the value date, is the day common to both countries in which the counterparties of the transaction will pay the agreed currency amount.[11] The process of determining value dates for FX transactions is precise. The settlement practices for FX trades through CLS are the following: spot transactions are settled two days after the trade date; the first leg of swap transactions can be settled same, next day, or (standard) two days after the trade date with the second leg determined at the time of the trade date, and forward transactions have a similar settlement profile as swaps.[12]

[11]FX transactions through the CLS Bank, where the national central banks act as intermediaries, can only be settled on business (banking) days common to both countries. European and North American banking holidays often coincide. This however is often not the case for Asia, Africa, and the Middle East.

[12]The settlement conventions for swaps are today-tomorrow at t (near leg) and t+1 (far leg); tom-next at t+1 and t+2; spot-next at t+2 and t+3; seven-day swap at t+2 and t+9; one-month swap at t+2 and t+32. Because, CLS settles individual legs of a swap separately, it is not possible to determine the instrument type of the settled transaction.

To gain a better sense of the strengths and the weaknesses of CLS data for empirical research, we compare CLS's properties with those of Electronic Broking Services (EBS) data. The main advantage of CLS data is its coverage. CLS's coverage includes the interdealer and brokerage market, whereas EBS's coverage includes only the interdealer market. Similarly, the products covered by CLS include the spot, swap, and forward market, whereas EBS data handle mainly the spot market.[13] The strengths of the EBS data lie in its ultra high frequency trading data and in the buyer and seller initiated trades. However, EBS data is typically available only in snap-shot form and does not offer a measure of volume size for our sample.[14] Because of the aca-

This includes the maturity structure. Today-tomorrow and tom-next are however primarily used for liquidity-management purposes and are more expensive in terms of their wider bid-ask spreads. Thus, the volumes of these operations are dominated by spot and swap transactions with the near leg at t+2.

[13]A related issue is volume size in the spot market. CLS spot market volume is just under four times larger: average daily figures for December 2007 - CLS USD 611 billion versus EBS USD 165 billion.

[14]ICAP have been offering the following versions of EBS datasets: Data Mine 1.0 including one second time slices of EBS best (last update in time slice) and of paid/given rate (lowest given /highest paid rate dealt within time slice); Data Mine 1.5 that in addition to Data Mine 1.0 includes Volume Indication - 'buckets' (i.e. seven size indicator letters; for instance, letter A indicates that the trading volume falls between one up to 3 millions);

demic literature's focus on signed transactions in the interbank market for order flow analysis (see Carlson and Lo, 2006; Evans and Lyons, 2005; and Evans and Lyons, 2008), these sought-after characteristics make EBS data particularly attractive. CLS data and settlement data in general are unable to reconstruct order flow patterns, because it does not recognize who initiated the trade. Despite this limitation, CLS data remains ideal for analyzing liquidity effects.[15]

2.2. Data properties of CLS volumes

The empirical sample based on CLS trading volume (unsigned gross flows) considers the top five most actively traded currencies: the U.S. dollar (USD), the euro (EUR), the Japanese yen (JPY), the British pound (GBP), and the Swiss franc (CHF).[16] The daily sample is from 1.1.2003 to 31.12.2007. The

Data Mine 2.0 includes actual volumes. The last generation of EBS data called "Level 4.0" also shows the best 5 up to 10 bids and offers volume. While Data Mine 1.0 (1.5) is available since 1997 (1999), the latest generation of EBS data including Data Mine 2.0 are available only for the most recent years.

[15]Despite the use of different data sets (i.e., CLS's broader coverage versus signed transactions), it should be noted that this paper and the literature on order flow are interested in similar issues of information arrival and price formation.

[16]According to the most recent BIS Triennial Survey (2007), the five currencies account for 80.1% (84.5%) of the total volume in 2007 (2004).

sample's size is restricted by CLS's introduction beginning in late September 2002. CLS currency volumes are denominated in U.S. dollar and are not corrected for double accounting.[17]

CLS currency volumes are characterized by large swings and positive trends.[18] The CLS data were filtered in the following manner. To deal with the inherent trends and the fact that CLS is a rapidly expanding market, we follow Chaboud and LeBaron (2001) as they filtered the data for the Chicago FX options market and create a detrended volume variable for each currency.[19] The variable, $NVOL_t$, is the ratio of today's trading volume to

[17]The data were given to us in aggregate form. This means in the case of the U.S. dollar flows, they include more trades than the trades for the four other examined currencies and these cannot be separated into different currency pairs. However, the CPSS 2007 survey shows that the currency breakdown of total CLS settlement obligations is very similar to that for the whole FX market (based on the BIS 2004 Triennial Survey: CPSS survey USD 45%, EUR 20%, JPY 7%, GBP 4%, and CHF 4% versus BIS survey USD 44%, EUR 19%, JPY 10%, GBP 8%, CHF 3%.

[18]Trading volume, for example, in the U.S. dollar fluctuated by more than 10% on days following a bank holiday and grew 1032% over the sample. In contrast, the volume in the Japanese yen is subject to smaller daily fluctuations and grew less than a third as quick (317%).

[19]The choice of 66 trading days corresponds roughly to three months. Estimates with 22, 33, and 100 moving averages were also examined. The size of the moving average did

a moving average of the previous 66 daily trading volumes

$$NVOL_t = \frac{vol_t}{\frac{1}{66}\sum_{i=1}^{66} vol_{t-i}}. \tag{1}$$

Next, bank holidays and expiration dates of futures contracts are dropped from the sample to reduce the variance and the effects of potential outliers for higher moments.

The trend correction in equation (1) does not eliminate daily and weekly effects. Following MacDonald and Marsh (1996) in their study on IMM futures volume, we filter the deterministic effects by regressing $ln(NVOL_t) = nvol_t$ on daily dummies and six lags:

$$nvol_t = const + \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t, \tag{2}$$

where Day_k is a dummy that captures day-of-the-week effects and ν_t is the error term.

Table 1 presents statistical information for the residuals from regression equation (2). The insignificant autocorrelation coefficients (AC) reveal that serial correlation is not a problem. Instead, the low p-values from the White and the ARCH(1) tests indicate that the filtered volume series are heteroskedastic. Information from the third and fourth moment shows that

not influence the results.

the distribution of the residuals is fat-tailed and subject to outliers.[20]

3. Hypotheses tests and empirical setup

The empirical analysis considers two separate hypotheses. Each states that FX traders reshuffle their portfolios on or after FOMC days. The first is the announcement timing hypothesis. This hypothesis says that global FX trading increases on FOMC days even when announcements are in line with market expectations. Chaboud et al. (2008) show evidence of a deterministic response for the USD/EUR and USD /JYN currency pairs using EBS volume data. This would be consistent with wait-and-see behavior. Carlson and Lo (2006) and Berger et al. (2008) argue that traders do not want to transact before and during an important news release because of uncertainty regarding its outcome.

The second hypothesis is the announcement surprise hypothesis. In addition to the deterministic pattern on FOMC days, FX trading can increase in response to new information. In particular, we are interested in whether the Kuttner (2001) measure of FOMC shocks unleashes further FX trading.

[20]Although the property of kurtosis for CLS volume is not captured in the standard price-volume relation of Karpoff (1987), we do not filter it from the data. In the empirical section, we also examined the effect of non-normal distributions in a GARCH specification.

This type of volume response is consistent with non common knowledge of Evans (2002) that says that either traders have private information or traders interpret public information differently.

Abnormal trading under the announcement timing hypothesis for five currencies (USD, EUR, JPY, GBP, and CHF) is first tested with the following equation:

$$nvol_t = const + \sum_{i=1}^{5} \beta_i FOMC_{t-i} + \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t, \quad (3)$$

where $FOMC_t$ is a dummy (i.e., $FOMC_t = 1$ when the FOMC meets, otherwise $FOMC_t = 0$) and again ν_t is the error term. Equation (3) follows Chaboud et al. (2008) with the direction criterion of $\beta_i > 0$. The relationship with the dummy variable says that FX volume on FOMC days is larger than the 66-day moving average prior to the meeting.

The dummy variable, $FOMC_{t-i}$, enters $i = \{1, \cdots, 5\}$ to capture FX trading in different FX markets. The first case is for $i = 1$ or 2.[21] Such a (settled) volume response implies that FX trading could take place prior or after the FOMC meeting. The response, for example, could be the first leg of a swap transaction (i.e., after the FOMC meets with immediate or one-day

[21]Note, we do not consider the contemporaneous case $i = 0$ for FOMC days, because CLS settlement closes at 12:00 EST before the FOMC news is released at 2:15 EST.

settlement) or a spot transaction (i.e., before the FOMC meets with two-day settlement).[22] Note, footnote 12 makes clear that other swap combinations are also possible.

The second and more interesting case is for $i = 3$. FX traders respond to news after the FOMC discloses its decision at 2:15 EST and is consistent with two-day settlement in the spot market for the five currencies examined in this study.[23] Since European (Japanese) markets are already closed (not yet open) when the FOMC concludes its deliberations, an international response occurs at $t+1$ and spot market settlement two days later at $t+3$. To capture the duration of abnormal FX volume or say the significance of spot-next swap transactions with settlement at *t+3* (near leg) and at *t+4* (far leg), we also consider days further out (i.e., $i > 3$).[24]

[22]Numerous studies find that FX markets respond before released information. Peiers (1997) and Dominguez (2003), for example, show that exchange rates respond before central banks intervene in the FX market.

[23]The CAD/USD exchange rate is an exception. It is the only major currency settled at $t + 1$.

[24]Endogeneity is not a problem in this context. The relation between trading volume and FOMC decisions can be interpreted as proof that information from FOMC meetings or anticipated news generate an increase in FX trading activity. This stems from the observation that high FX volume does not cause scheduled FOMC meetings.

To test the announcement surprise hypothesis, we follow Chaboud et al. (2008) and add $FOMC_{t-1}{}^{*}|\epsilon^{FF}_{t-1}|$ and lags along with $|\epsilon^{FF}_{t-1}|$ and lags to equation (3):

$$\begin{aligned} nvol_t &= const + \sum_{i=1}^{5} \beta_i FOMC_{t-i} + \sum_{f=1}^{5} \kappa_f |\epsilon^{FF}_{t-f}| + \sum_{g=1}^{5} \omega_g FOMC_{t-g} * |\epsilon^{FF}_{t-g}| \\ &\quad + \sum_{h=1}^{5} \delta_h |\Delta s^{USD}_{t-h}| + \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t. \end{aligned} \tag{4}$$

The measure of (absolute) policy surprise, $|\epsilon^{FF}_t|$, follows Kuttner (2001) rather than the less precise measure based on MMS survey data used in Chaboud et al. (2008). The Kuttner surprise measure is based on price changes in the federal funds futures contracts (appropriately re-scaled).[25] Following standard practice, we construct our FOMC shock by working with a 30-minute window between 2:10 EST and 2:40 EST to capture the policy surprise before and after the release of the FOMC statement at 2:15 EST. The significance of $|\epsilon^{FF}_t|$ is more stringent than the significance of the FOMC

[25]For example, the 1-day surprise is $\epsilon^{FF}_t = m/(m-t)[f^0_{s,t} - f^0_{s,t-1}]$, where the spot-month futures rate on day t with m days for month s is $f^0_{s,t}$. This is valid for all but the first day of the month, on which the 1-month futures rate from the last day of the previous month, $f^1_{s-1,m}$ is used instead of $f^0_{s,t-1}$. Numerous empirical studies find the federal funds futures contract to be an extremely efficient measure for market expectations of future monetary policy, see Kreuger and Kuttner (1996), Kuttner (2001), Piazzesi and Swanson (2008), Sack (2002), and Gürkaynak et al. (2007).

dummy. The variable with a 30-minute window ensures that the volume response is being driven by FOMC actions and not other factors that coincide with FOMC days.

Equation (4) also controls for the interaction between absolute FX returns, FX volume, and FOMC events. Jones et al. (1994), Karpoff (1987), and others have identified a positive correlation between volume and absolute returns for prices of various assets. Higher price volatility is linked with higher volume activity primarily in the tails of the distribution. To control for absolute returns for the dollar in the volume-FOMC relation, we construct a measure of absolute price returns. Such a measure is necessary, because the CLS Bank does not provide an average currency price for settled trades. We build a (daily) trade weighted variable under the assumption that the spot price at noon EST is a valid proxy for settled transactions with CLS Bank.[26] We denote the (daily) absolute dollar return as $|\Delta s_{t-1}^{USD}|$ and add this variable and four further lags to equation (4).

Equation (4) is motivated by the asset market approach to exchange rates

[26]The trade weighted average is constructed using normalized exchange rates multiplied by the respective volume shares. Exchange rates are spot rates from the Federal Reserve Bank of New York with a noon time stamp. The results presented in the next section are not sensitive to other daily spot rate quotes.

with homogenous agents, see Lyons (2001). Bonser-Neal et al. (1998) argue that FOMC news changes expectations, causing the exchange rate to jump to a new level. In our case, a significant coefficient for the cross product, $|\epsilon_t^{FF}| * FOMC_t$ (i.e., $\omega_g > 0$ and $\beta_i = 0$) is consistent with the view that FOMC communication drives global FX volume proportionally to the size of the surprise. Alternatively, if $FOMC_t$ remains significant even in the presence of $|\epsilon_t^{FF}|$, such evidence says that the abnormal trading pattern has a deterministic element. In other words, some traders prefer to wait and not to be wrong footed by a surprise FOMC decision and resume trading after the FOMC news is released.

4. Estimation results

This section presents evidence of abnormal FX volume for 40 scheduled FOMC days from 1.1.2003 to 31.12.2007.[27] First, the relationship between FX volume and FOMC meetings as under the announcement timing hypothesis is established. Next, we show that this deterministic relation is contingent on FOMC news type. Last, evidence for the announcement surprise hypoth-

[27]The FOMC released a statement on 14.08.2007. We did not include this meeting as a scheduled FOMC meeting. The inclusion or exclusion of this observation has no bearing on our results.

esis is presented.

4.1. Global FX activity and FOMC meetings

This subsection documents evidence of abnormal FX activity following FOMC meetings based on the variable of interest, $FOMC_{t-i}$ for $i = \{1, \cdots, 5\}$, in equation (3). Table 2 summarizes evidence for five currency volumes: USD, EUR, JPY, GBP, and CHF. The coefficient estimates for daily effects and lagged $nvol_{t-j}$ are not shown. Information from Table 2 highlights two observations about FOMC meetings. The first is that there is a (near) synchronous response for the five currencies. Currency volume increases on FOMC days at $t-3$ and $t-4$ and falls at $t-5$. The directional pattern is however not significant across currency volumes. The second observation is that only the major three currencies show significant evidence of an abnormal volume response following an FOMC meeting at the 5% level.[28] GBP and CHF volume do not respond significantly to FOMC meetings and is possibly explained by their higher variances (see standard deviations in Table 1).[29]

[28] All standard errors are corrected using White heteroskedastic-consistent standard errors. A GARCH setup revealed that our empirical results are not sensitive as to how we model the variance or whether SUR estimation is used.

[29] The fact that international markets do not react uniformly to news has been recently documented by Ehrmann and Fratzscher (2005).

A closer look at the strongest volume response to FOMC days reveals that USD volume increases in the order of 5% at $t-3$ and $t-4$. This volume response translates into a volume boost of USD 49 billion. Table 2 shows that $FOMC_{t-3}$ is significant at the 1% level and $FOMC_{t-4}$ at the 5% level. The strong USD volume response stems from the observation that cross-currency activity outside of the dollar is limited and that hedging possibilities are scarce outside the major currencies. The lagged effect for $FOMC_{t-3}$ and $FOMC_{t-4}$ is consistent with international portfolio reshuffling in the spot market (settled at *t+2*) or possibly by hedging activity through spot-next swaps (settled at *t+2* and *t+3*) after the FOMC concludes its deliberations.

Figure 1 presents the same information in Table 2 for a larger time horizon. It shows the average change in USD volume 2 days before and 15 days after FOMC days. More specifically, the figure plots the coefficient values for $FOMC_t$ from 18 regressions specified by equation (2) with $FOMC_{t-i}$ for i = {-2, -1, $\cdots$, 14, 15}. The daily changes in USD volume swing between -4% and +5%. FX volume increases on FOMC days at time t and following the FOMC meeting at $t-3$ and $t-4$ and then tappers off. During the 10-day period from $t-5$ to $T-14$, FX volume declines by an accumulated 20%.[30]

[30]Bomfim (2000) and Jones et al. (1998) claim FOMC days calm stock and bond

In Figure 1, we identify two separate announcement effects for separate FX markets. First, the post-announcement effect at $t-3$ and $t-4$ in the regression equations is a volume increase linked to the $t+2$ settlement in the USD spot market or possibly spot-next swaps with settlement at $t+2$ for the near leg and settlement at $t+3$ for the far leg, reconfirming the evidence in Table 2. Second, the pre-announcement effect at t is consistent with trading activity in the swap market.[31] Carlson and Lo (2006) and Chaboud et al. (2008) show for Reuters and EBS platforms that FX volume in the spot market increases after announcements but not before the announcement. The absence of abnormal volume in the spot market implies for the aggregate CLS measure that abnormal activity comes from the swap market. One explanation for the distinct response behavior is the following. Investors seek protection before an FOMC announcement using primarily swap and reshuffle their portfolios on the basis of new information after the FOMC announcement using mainly the spot market.

To understand whether the result of increased FX volume on FOMC days holds for other central bank meetings, Table 3 presents information on

volatility. This calming effect can be visually identified in Figure 1, but it is not supported by empirical tests using a GARCH setup.

[31] Recall, the swap market is almost five times larger than the forward market.

FX volume and scheduled central bank meetings by the European Central Bank (ECB), the Bank of Japan (BoJ), and the Bank of England (BoE).[32] FX volume is for USD volume and domestic currency volume. Unlike in the case of FOMC days, no congruous response pattern of abnormal volume emerges for either currency volume for ECB, BoJ, or BoE meetings. The central bank dummy is never significant at any lag order. The observation that FX activity responds stronger to FOMC meetings than other central bank meetings is consistent with Almeida et al. (1998) that examine the price response of currencies to central bank news.[33] We interpret the timing evidence based on dummy variable analysis in Tables 2 and 3 as follows: FX volumes increase strongly after the FOMC meetings but not for other central bank meetings.

[32]Abnormal volume on Swiss National Bank days was not considered, because the number of (non overlapping) observations is less than 10.

[33]The importance of news from FOMC meetings on FX markets versus news from other central banks has also been examined for money announcements by Ito and Roley (1987) and central bank interventions by Dominguez (2003). More recent comparative studies on central bank communication by Ehrmann and Fratzscher (2007) find that FX markets do not respond equally to central bank news.

4.2. USD volume and FOMC actions

The previous subsection treated FOMC days as a deterministic effect irrespective of FOMC actions. In this subsection as an extension to the announcement timing hypothesis, we are interested in the information content of the FOMC timing effect. First, we consider whether days when the FOMC changed the federal funds rate target generated a stronger volume response than on days when the FOMC undertook no change in the target. Table 4 summarizes this information for USD volume. For comparative purposes, the results from $FOMC_{t-i}$ are presented in the first column. In columns (2) and (3) of Table 4, regression estimates for separate FOMC actions are presented: *change in FF* is a dummy for 18 FOMC days when a change in the federal funds rate target occurred and *no change in FF* is a dummy for 22 FOMC days when the federal funds rate target remained unchanged. Again, we use equation (3) as our baseline model and show coefficient estimates for the FOMC dummy only. The regressions for federal funds rate changes or no changes show that the delayed volume response at $t-3$ and $t-4$ (attributed to two-day settlement in the cash market) holds. However, USD volumes respond stronger to FOMC days with a change in the federal funds rate target (column 2) than when no change occurred (column three), suggesting that

FOMC actions move markets. A null hypothesis of coefficient equality for the two types of FOMC days is rejected with a p-value of 0.001.

Next, we consider the influence of future interest rate leanings on FX volume. As in Pakko (2005) and Thornton and Wheelock (2000), we review the FOMC statements and classify future FOMC leanings (i.e., future interest rate cuts or increases) into neutral and non-neutral categories. The latter group is when the FOMC statement states that if the current assessment of the balance of risks materializes then future changes in the federal funds rate target are warranted, while the former do not indicate a change in the future path of interest rates.[34] There are 21 neutral leanings versus 19 non-neutral leanings. Columns (5) and (6) in Table 4 show coefficient estimates for non neutral and neutral FOMC leanings from separate regressions. The coefficient estimates show that non neutral leanings with up to the fourth lag generate a larger reaction in USD volume than do neutral leanings. Imminent changes in FOMC policy heighten FX activity. USD volume does not react to our measure of neutral leanings. The null hypothesis that neutral and non-neutral leanings have the same effect on USD volume is rejected with a p-value of 0.006.

[34]Our classification is available upon request.

4.3. USD volume and federal funds futures

To test the announcement surprise hypothesis, we consider whether USD volume responds to the magnitude of the FOMC policy surprises as defined by equation (4). Table 5 summarizes the expanded regressions for the (lagged) cross product of $FOMC_t{}^*|\epsilon_t^{FF}|$. The main result is that $FOMC_{t-3}{}^*|\epsilon_{t-3}^{FF}|$ is always significant for alternative specifications, upholding the earlier volume-FOMC relation for the spot market. Column (1) presents cross product coefficients from a regression of USD volume on the $FOMC_{t-i}{}^*|\epsilon_{t-i}^{FF}|$ for $i = \{1, \cdots, 5\}$ with the day-of-the-week dummies and six lags of USD volume. Only the coefficients for $FOMC_{t-i}{}^*|\epsilon_{t-i}^{FF}|$ for $i = \{1, \cdots, 5\}$ are shown in Table 5. The variable, $FOMC_{t-3}{}^*|\epsilon_{t-3}^{FF}|$, has an extremely large coefficient. A 1% price change (within a half hour time span) in the federal funds futures contract will increase FX trading by more than 200% for an FOMC day.[35] The variable, $FOMC_{t-3}{}^*|\epsilon_{t-3}^{FF}|$, is significant at the 1% level.[36]

[35]This point estimate of 238 divided by 48 hour sessions or 238/48 = 4.96 is consistent with the daily results of 5% in Table 2.

[36]The significance at *t+3* is also reconfirmed with OIS rates for the USD. The volume response with OIS rates for other currencies (as conducted with dummies in Table 3) however is not significant. This result lends further support that FOMC surprises generate stronger volume responses than policy surprises from other central banks. We thank

Column (2) of Table 5 shows that the coefficient estimates for $FOMC_t{}^*|\epsilon_t^{FF}|$ are sensitive to the addition of $FOMC_t$ and five lags. Although the significance of $FOMC_{t-3}{}^*|\epsilon_{t-3}^{FF}|$ is upheld, the F-test of the FOMC dummies in column (2) shows that these variables are also significant. The significance of FOMC dummies together with $FOMC_t{}^*|\epsilon_t^{FF}|$ means that both timing and surprise effects are present on FOMC days.

Columns (3) and (4) show that the significance of $FOMC_{t-3}{}^*|\epsilon_{t-3}^{FF}|$ holds when controlling for $|\epsilon_{t-1}^{FF}|$ and four further lags in the specifications defined in columns (1) and (2). The p-value for an F-test for the the FOMC dummies shown in column (4) is 0.07. Again, this result says that the FOMC dummies are capturing information around FOMC days that is not correlated with policy surprises, $|\epsilon_t^{FF}|$. An F-test for the (joint) null hypothesis that the coefficients for $|\epsilon_{t-f}^{FF}|$ for $f = \{1, \cdots, 5\}$ are zero cannot be rejected.[37]

The evidence of the return-volume relation on FOMC days is presented in columns (5) and (6) of Table 5. The main result is that the volume response to FOMC days holds even when we control for absolute returns. The variable,

Michael King from the BIS for providing us the OIS data.

[37]We experimented with different windows for $|\epsilon_t^{FF}|$. Regardless if the window is 30 minutes or open to close the results did not change. This result confirms the results in Gürkaynak et al. (2005) for monetary policy shocks and asset prices.

$FOMC_{t-3}{}^{*}|\epsilon_{t-3}^{FF}|$, remains significant at the 5% level regardless whether we control for $FOMC_t$ (see column 6). The variable, $|\Delta s_t^{USD}|$, is found to be positively correlated with daily USD volume. The p-values of the F-test show that absolute price returns are significant at conventional levels, extending Karpoff's (1987) finding of return-volume relation for currency markets.[38] From the significant F-test for $FOMC_{t-g}$, it is possible to determine that large FX volume activity at the time of the FOMC meeting is associated with large exchange rate movements in prices.

We interpret the evidence in Tables 2 to 5 as follows. FOMC meetings are events that generate an increase in FX volume for the three largest currencies. Abnormal FX trading, particularly for the USD, is observed with a lag following the FOMC meeting and has a duration of two business days. This duration is longer than FX price responses to FOMC news, see Ahn and Melvin (2007), Andersen et al. (2003), Bonser et al. (1998), Faust et al. (2006), and Hausman and Wongswan (2006). The lagged response in FX volume is consistent with two-day settlement in the FX spot market.

It is important to qualify our results in light of potential weaknesses.

[38]It is important to recall that, unlike $FOMC_{t-3}{}^{*}|\epsilon_{t-3}^{FF}|$, $|\Delta s_t^{USD}|$ should not be treated as a causal variable of FX volume.

First, Andersen et al. (2003) showed that FX markets respond to a range of newswire releases and financial market surveys. Our study focuses on FOMC meetings as a driver of FX volume, thus an open issue is the FX volume response to FOMC days relative to other forms of macroeconomic news. Second, our sample is dominated by low financial market volatility, see Panetta et al. (2006). Third, the analysis focused on the FX volume response to 40 FOMC meetings. Event studies on FOMC days range between 10 (see Ahn and Melvin, 2007) and 199 observations (see Rudebusch, 1995). It cannot be excluded that the study's empirical results are subject to a small sample bias.

5. Conclusions

The empirical evidence of abnormal FX trading after FOMC meetings has important implications for how researchers view global financial linkages in currency markets. First, consistent with the announcement timing and the announcement surprise hypotheses, FOMC meetings are events that unleash considerable portfolio reshuffling. Alone the timing effect is responsible for an FX liquidity effect in the order of 5% on FOMC days. Second, we show that controlling for the swap and forward market, the FOMC timing and

FOMC surprise effects are predominately in the spot market and in the spot-next swap market. These liquidity effects on FOMC days are consistent with Chaboud et al. (2008) that focus strictly on the EBS platform. Third, the evidence shows that it is difficult to make statements about central bank transparency without knowing the behavior of FX volume. Even if central banks communicate transparently and moderate price responses are observed, this should not be necessarily interpreted that international portfolio shifts are small.

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Table 1

Residual properties of the (filtered) CLS series (2003-2007)

	CHF	EUR	GBP	JPY	USD
Mean	0.0000	0.0000	0.0000	0.0000	0.0000
Median	-0.0041	-0.0086	-0.0082	-0.0059	-0.0019
Maximum	0.8255	0.6812	0.7091	0.7314	0.6824
Minimum	-0.3899	-0.3804	-0.4282	-0.3711	-0.6525
Std. Dev.	0.1256	0.1220	0.1251	0.1294	0.1194
Skewness	0.7948	0.7676	0.9166	1.2677	0.4614
Kurtosis	7.1409	5.8413	7.0585	8.6141	9.4118
Jarque-Bera	534.4920	318.5398	574.3131	905.9700	1307.8420
Observations	652	733	695	573	745
AC1	**0.0400**	0.0040	-0.0090	-0.0090	-0.0020
AC2	0.0180	-0.0150	-0.0020	-0.0180	-0.0220
AC3	-0.0100	-0.0130	0.0020	-0.0160	0.0010
AC4	-0.0300	**-0.0500**	0.0170	-0.0290	**-0.0540**
AC5	-0.0010	0.0110	-0.0020	-0.0180	-0.0260
AC6	**-0.0570**	-0.0020	-0.0070	-0.0110	-0.0230
AC7	0.0130	-0.0180	-0.0180	0.0020	-0.0080
AC8	0.0030	0.0000	-0.0330	0.0080	0.0090
AC9	-0.0290	0.0200	0.0210	0.0080	0.0170
AC10	-0.0010	-0.0130	0.0350	0.0110	-0.0250
White test No cross terms	0.0590	0.1791	0.0610	0.0003	0.0098
Cross terms	0.0061	0.9734	0.0061	0.0003	0.0097
ARCH(1)	0.0566	0.0822	0.0089	0.0151	0.0265
ARCH(2)	0.1805	0.2188	0.0928	0.0430	0.1285
ARCH(5)	0.3626	0.1678	0.2562	0.2556	0.4160

FX volume in USD and filtered with a 66-day moving average trend excluding holidays, futures expiration dates, and seasonality. AC(x) denotes autocorrelation coefficient order x. Bold numbers denotes significant at the 5% level. White test gives the p-values. ARCH(x) p-values of an ARCH test order x.

Table 2

FX volume and FOMC meetings

$$nvol_t = \text{const} + \sum_{i=1}^{5} \beta_i FOMC_{t-i} + \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t$$

currency $nvol_t$	USD	EUR	JPY	GBP	CHF
$FOMC_{t-1}$	-0.0009	-0.0003	0.0264	0.0162	0.0035
	(0.0328)	(0.0394)	(0.0437)	(0.0447)	(0.0272)
$FOMC_{t-2}$	-0.0243	-0.0278	-0.0148	-0.0320	0.0469**
	(0.0286)	(0.0238)	(0.0256)	(0.0284)	(0.0234)
$FOMC_{t-3}$	0.0546***	0.0187	0.0479**	0.0022	0.0100
	(0.0203)	(0.0177)	(0.0239)	(0.0218)	(0.0271)
$FOMC_{t-4}$	0.0449**	0.0342*	0.0452**	-0.0108	0.0041
	(0.0197)	(0.0179)	(0.0213)	(0.0235)	(0.0202)
$FOMC_{t-5}$	-0.0300	-0.0461*	-0.0054	-0.0079	-0.0205
	(0.0221)	(0.0277)	(0.0274)	(0.0263)	(0.0252)
Number of Obs.	745	804	643	763	804
R^2	0.421	0.540	0.452	0.473	0.449

$nvol_t$ is FX volume for five currencies (USD, EUR, JPY, GBP, CHF), $FOMC_t$ is a dummy for FOMC days, and Day_k is a day-of-the-week dummy. Only the coefficients for $FOMC_t$ in the above regression are shown. *, **, and *** denotes significance at the 10%, the 5% and the 1% level. White heteroskedastic consistent standard errors are given in parentheses. Sample is from 1.1.2003 to 31.12.2007. Number of observations differ because of national banking holidays.

Table 3

FX volume and BoJ, ECB, and BoE meetings

$$nvol_t = \text{const} + \sum_{i=1}^{5} \beta_i CB_{t-i} + \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t$$

currency $nvol_t$	USD	USD	USD	EUR	JPY	GBP
Central Bank Meeting CB_t	ECB	BoJ	BoE	ECB	BoJ	BoE
CB_{t-1}	0.0161	0.0332	-0.0421**	-0.0120	0.0317	-0.0543***
	(0.0267)	(0.0238)	(0.0179)	(0.0305)	(0.0351)	(0.0189)
CB_{t-2}	-0.0169	0.0253	0.0241	0.0159	-0.0047	0.0396
	(0.0316)	(0.0251)	(0.0238)	(0.0218)	(0.0380)	(0.0286)
CB_{t-3}	-0.0073	-0.0344	0.0251	-0.0126	-0.0038	-0.0233
	(0.0163)	(0.0282)	(0.0239)	(0.0208)	(0.0334)	(0.0300)
CB_{t-4}	-0.0060	-0.0375	0.0250	0.0058	-0.0342	0.0078
	(0.0197)	(0.0272)	(0.0213)	(0.0214)	(0.0318)	(0.0346)
CB_{t-5}	-0.0192	-0.0424	-0.0028	-0.0403	-0.0141	0.0156
	(0.0191)	(0.0324)	(0.0274)	(0.0259)	(0.0319)	(0.0214)
Number of Obs.	745	810	810	768	643	760
Number of CB meetings	55	38	52	55	38	52
R^2	0.452	0.447	0.452	0.549	0.452	0.474

$nvol_t$ is FX volume for four currencies (USD, EUR, JPY, GBP), CB_t is a dummy for three central bank meetings (ECB, BoJ, BoE) and Day_k is a day-of-the-week dummy. Only the coefficients for CB_t in the above regression are shown. *, **, and *** denotes significance at the 10%, the 5% and 1% level. White heteroskedastic consistent standard errors are given in parentheses. Sample is from 1.1.2003 to 31.12.2007. Number of observations differ because of national banking holidays.

Table 4

USD volume and FOMC type

$$nvol_t = \text{const} + \sum_{i=1}^{5} \beta_i FOMC^*_{t-i} + \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t$$

	(1)	(2)	(3)	(4)	(5)
$FOMC^*_t$	All ($FOMC_{t-i}$)	Change in FF	No Change in FF	non neutral leanings	neutral leanings
$FOMC^*_{t-1}$	-0.0009	0.0399	-0.0068	0.0404	0.0092
	(0.0328)	(0.0588)	(0.0258)	(0.0510)	(0.0358)
$FOMC^*_{t-2}$	-0.0243	-0.0586	0.0353	-0.0291	-0.0430
	(0.0286)	(0.0429)	(0.0272)	(0.0491)	(0.0360)
$FOMC^*_{t-3}$	0.0546**	0.0721***	0.0476***	0.0737**	-0.0243
	(0.0203)	(0.0177)	(0.0209)	(0.0345)	(0.0362)
$FOMC^*_{t-4}$	0.0449**	0.0647***	0.0675***	0.1001***	0.0217
	(0.0197)	(0.0179)	(0.0265)	(0.0296)	(0.0411)
$FOMC^*_{t-5}$	-0.0300	0.0148	0.0004	0.0301	0.0815**
	(0.0221)	(0.0255)	(0.0306)	(0.0283)	(0.0416)
Number of Obs.	745	745	745	745	745
Number of FOMC meetings	40	18	22	19	21
R^2	0.421	0.417	0.406	0.417	0.413

$nvol_t$ is USD volume only, $FOMC^*_t$ is a dummy for FOMC days and the following conditions (FOMC day, change in the federal funds rate target (FF), no change in the federal funds rate target, non neutral leaning, neutral leaning) and Day_k is a day-of-the-week dummy. Only the coefficients for $FOMC^*_t$ in the above regression are shown. *, **, and *** denotes significance at the 10%, the 5%, and the 1% level. White heteroskedastic consistent standard errors are given in parentheses. Sample is from 1.1.2003 to 31.12.2007.

Table 5

USD volume and FOMC shocks

$$nvol_t = \text{const} + \sum_{i=1}^{5} \omega_i FOMC_{t-i}{}^*|\epsilon_{t-i}^{FF}| + \sum_{f=1}^{5} \kappa_f |\epsilon_{t-f}^{FF}| + \sum_{g=1}^{5} \beta_g FOMC_{t-g} + \sum_{h=1}^{5} \delta_h |\Delta s_{t-h}^{USD}|$$
$$+ \sum_{k=1}^{4} \alpha_k Day_k + \sum_{j=1}^{6} \gamma_j nvol_{t-j} + \nu_t$$

	(1)	(2)	(3)	(4)	(5)	(6)
restrictions in (4)	$\delta_h = \beta_g = \kappa_f = 0$	$\delta_h = \kappa_f = 0$	$\delta_h = \beta_g = 0$	$\delta_h = 0$	$\beta_g = 0$	none
$FOMC_{t-1}{}^*\|\epsilon_{t-1}^{FF}\|$	0.6765	0.8708	1.1243	1.4632	1.3032	1.5812
	(1.3754)	(1.3572)	(1.5091)	(1.4856)	(1.5391)	(1.5171)
$FOMC_{t-2}{}^*\|\epsilon_{t-2}^{FF}\|$	1.1447	1.7143	1.8773	2.0417	1.7391	1.8860
	(1.1835)	(1.3882)	(1.3337)	(1.3328)	(1.2564)	(1.2594)
$FOMC_{t-3}{}^*\|\epsilon_{t-3}^{FF}\|$	2.3689***	2.0502***	1.9988**	1.9303**	2.0571**	1.9303**
	(0.5606)	(0.5974)	(0.83332)	(0.8541)	(0.8321)	(0.8527)
$FOMC_{t-4}{}^*\|\epsilon_{t-4}^{FF}\|$	1.2539	0.6123	1.3207	1.3750	1.0528	1.0989
	(0.7832)	(0.7081)	(0.9928)	(0.9610)	(0.9074)	(0.8918)
$FOMC_{t-5}{}^*\|\epsilon_{t-5}^{FF}\|$	-0.0571	-0.0037	0.0252	0.0935	0.2653	0.3050
	(0.4309)	(0.4916)	(0.6374)	(0.6181)	(0.6348)	(0.6138)
Sig. Test (p-value)						
$\Sigma_{f=1}^{5} \kappa_f \|\epsilon_{t-f}^{FF}\|$			0.813	0.918		
$\Sigma_{h=1}^{5} \delta_h \|\Delta s_{t-h}^{USD}\|$					0.090	0.016
$\Sigma_{g=1}^{5} \omega_g FOMC_{t-g}$		0.050		0.070		0.012
Number of Obs.	745	745	745	745	745	745
R^2	0.412	0.422	0.414	0.428	0.423	0.436

$nvol_t$ is USD volume, $FOMC_t$ is a dummy for FOMC days, $|\epsilon_t^{FF}|$ is the absolute value of federal funds rate shock defined by Kuttner (2001), $|\Delta s_t^{USD}|$ is the absolute daily price change in (trade weighted) US dollar, and Day_k is a day of the week dummy. Only the coefficients for $FOMC_t{}^*|\epsilon_t^{FF}|$ in the above regression are shown. Sig. Test is an F-test for the significance of the listed variables and their lags (p-values are shown). *, **, and *** denotes significance at the 10%, the 5%, and 1% level. White heteroskedastic consistent standard errors are given in parentheses. Sample is from 1.1.2003 to 31.12.2007.

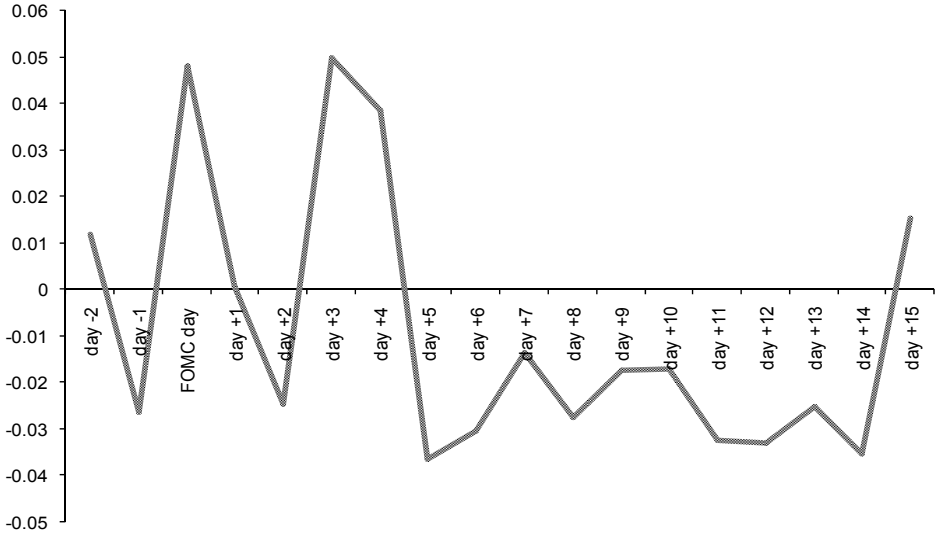

Fig. 1. Average change in USD volume before and after a FOMC day