

Technical Note Concerning the Methodology for Calculating the Effective Federal Funds Rate

July 8, 2015

The effective federal funds rate (EFFR) is currently calculated as a volume-weighted mean using data collected from major federal funds brokers. In February 2015, the Federal Reserve Bank of New York announced that it intended to change the data source used to calculate the EFFR to a newly instituted Federal Reserve data collection, the FR 2420 Report of Selected Money Market Rates.¹ The use of this collection, which provides the Federal Reserve with daily, transaction-level information on federal funds borrowing reported directly by depository institutions, will allow for a more robust calculation process. As part of the preparation for this change, the calculation methodology for the EFFR was reviewed to determine whether enhancements could be made to improve the EFFR as a measure of trading conditions in the federal funds market.

The review concluded that the calculation methodology of the EFFR could be improved by moving to a volume-weighted median measure concurrently with the change in data source. Historically, the volume-weighted median is the same as, or very close to, the volume-weighted mean at most times, and the review concluded that the former is likely to be a more appropriate measure of trading conditions in the federal funds market on most occasions where the two measures differ appreciably. In addition, the analysis showed that the use of a volume-weighted median will likely enhance the reliability and integrity of the EFFR.

Accordingly, following a discussion with the Federal Open Market Committee (FOMC) that was reported in the minutes of the June 2015 FOMC meeting, the New York Fed announced that it will implement this change in methodology.² That announcement indicated that the New York Fed would likely implement the change in the first few months of 2016, at which time revisions to the FR 2420 data collection are anticipated to be complete and the data are expected to be well-established.³

This technical note summarizes Federal Reserve staff analysis related to the change in the calculation methodology.⁴ It proceeds in three sections. The first section explores the concepts of the median and mean, discusses their historical behavior as summary measures of the federal funds rate, and concludes that the use of a median instead of the mean should have little overall effect on the level of the EFFR under most circumstances. The second section discusses how the median is more robust to data errors.

¹ See "[Statement Regarding Planned Changes to the Calculation of the Federal Funds Effective Rate and the Publication of an Overnight Bank Funding Rate](#)," February 2, 2015.

² See "[Statement Regarding the Calculation Methodology for the Effective Federal Funds Rate and Overnight Bank Funding Rate](#)," July 8, 2015.

³ On February 2, 2015, the New York Fed [announced](#) that it will begin publishing an overnight bank funding rate (OBFR), which will comprise both federal funds and the Eurodollar transactions of U.S.-managed banking offices. Although the analysis described in this technical note was conducted using federal funds data, the conclusions apply more broadly to overnight unsecured markets. As a result, the OBFR will also be calculated as a volume-weighted median when publication commences.

⁴ The [time series data](#) shown in this note are available for download on the New York Fed's website. These data include an estimated historical series of a median rate, based on brokered federal funds data, from January 2005 to June 17, 2015.

The third section explains how the use of a median should help ensure that the EFR provides a stable and useful measure of conditions in short-term money markets even on days when volumes or the number of transactions are low.

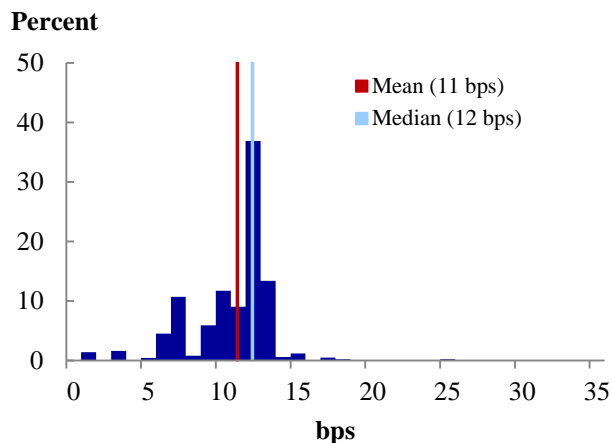
1. Background on the Median and Mean

Definitions of the Two Rates

Conceptually, a median and a mean are both measures of central tendency. A volume-weighted mean rate is calculated by summing together the weighted rates (the rate times the volume traded at that rate) for all transactions and dividing this sum by total volume of all transactions. A volume-weighted median rate is calculated by ordering the transactions from lowest to highest rate, taking the cumulative sum of volumes of these transactions, and then identifying the rate associated with the trades at the 50th percentile (middle) of dollar volume.⁵ Henceforth in this note, the term “mean” refers to the volume-weighted mean and “median” refers to volume-weighted median. In both cases the calculated measures are rounded to the nearest basis point.

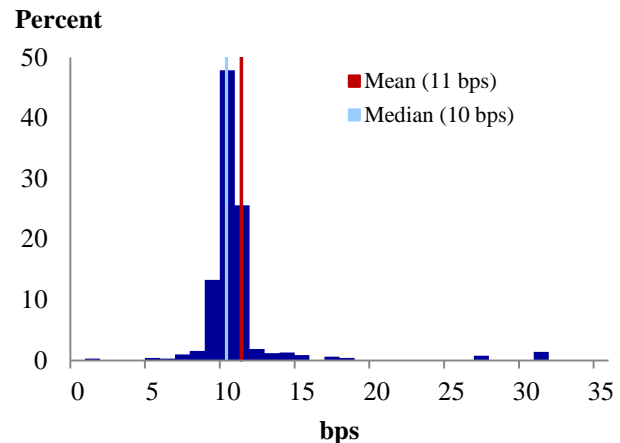
The distribution of traded rates in the federal funds market is often skewed. This skewness can result in differences between the means and medians, as illustrated in Figures 1 and 2. Figure 1 shows an example of a day on which the distribution is skewed towards lower rates, and Figure 2 shows a day on which the distribution is skewed towards higher rates. In both cases, the mean is influenced by these tails and therefore fixes at a level one basis point away from where the bulk of trading takes place. The median, in contrast, is less sensitive to the tails.

Figure 1: Rate Distribution - 1/26/15



Source: Calculated from FR 2420 data
Note: Rates rounded to the nearest basis point

Figure 2: Rate Distribution - 12/15/14

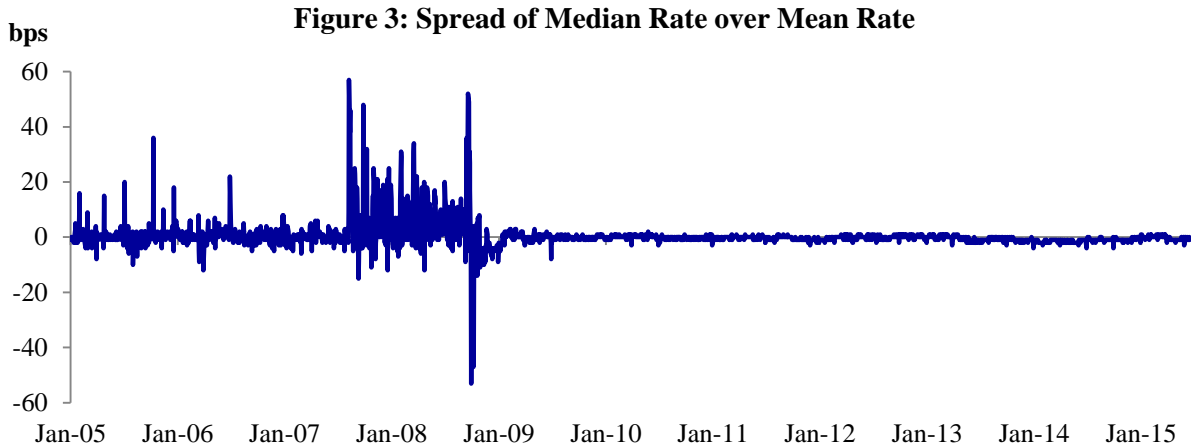


Source: Calculated from FR 2420 data
Note: Rates rounded to the nearest basis point

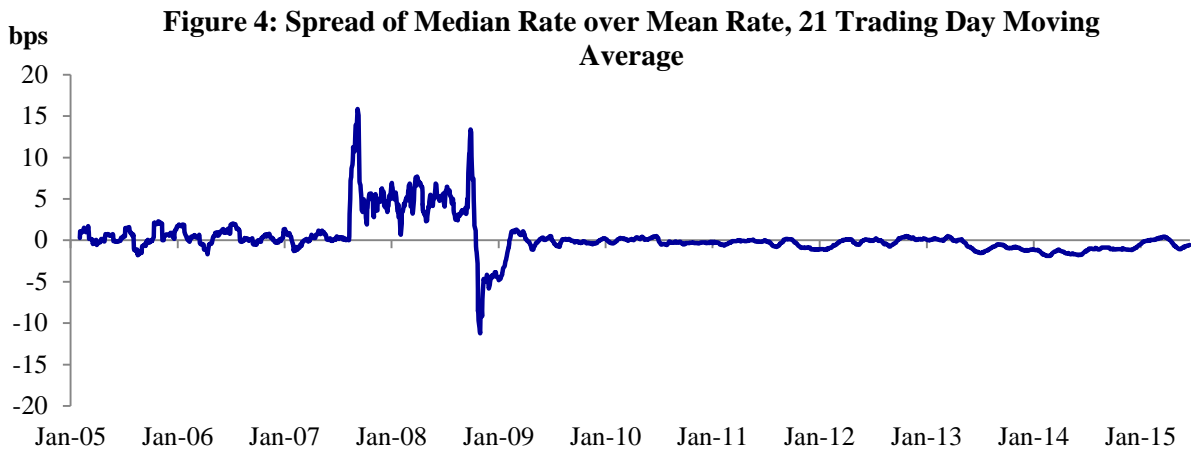
⁵ For example, assume that on a given day, \$10 million of federal funds transactions occurred at each of 5, 10, 15 and 20 basis points, and \$60 million occurred at 25 basis points. This represents \$100 million of total volume. The median would be the rate at the ‘middle dollar’, or \$50 million, which is 25 basis points in this example. The mean of this data is 20 basis points.

Historical Differences between the Median and Mean

Despite the possibility of skew, historically, differences between the mean and median have usually been small—a few basis points or less. This can be seen in Figure 3, which shows the historical differences between the mean and median as calculated from brokered federal funds data, and in Figure 4, which shows this difference calculated as a rolling 21 trading day average.⁶



Source: Calculated from data supplied by federal funds brokers
Note: Rates rounded to the nearest basis point

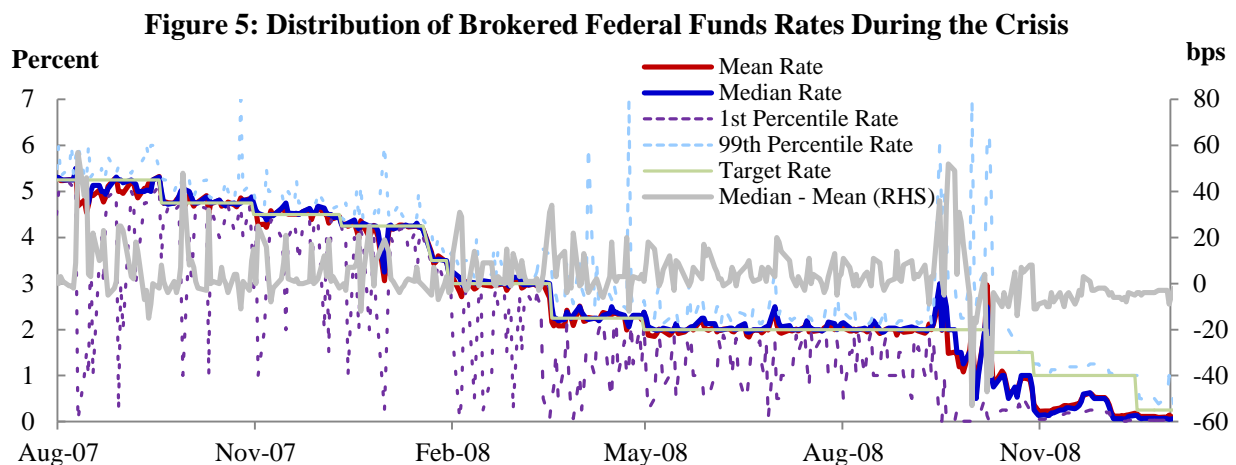


Source: Calculated from data supplied by federal funds brokers
Note: Rates rounded to nearest basis point. Moving average of the spread is unrounded.

⁶ Historical trade-by-trade federal funds data are not available for periods before the introduction of the FR 2420 collection. However, the Federal Reserve has for some time collected daily aggregate brokered federal funds volumes by rate. These data allow for the calculation of an estimated historical series of a median rate. This series can be compared to the historical EFFR, which was calculated as a mean, to gain analytical insight on the differences between the median and mean.

With the exception of the period of acute money market stress associated with the financial crisis, the median has been generally very close to the mean.⁷ Indeed, excluding the crisis period, the average absolute difference between the daily mean and median was about 0.9 basis points. This difference was greater than or equal to 5 basis points on only 1.9 percent of days, including only twice in the post-crisis period.

Almost all of the large differences between the median and mean occurred during the crisis period.⁸ These large differences were associated with unusually wide intraday ranges of rates on federal funds transactions, with substantial amounts of trading often occurring at rates far from—usually, far below—the bulk of volumes in the federal funds market. For example, as shown in Figure 5, the 1st percentile of traded rates was at times appreciably below the FOMC’s target for the federal funds rate.⁹ These unusual tails had a significant impact on the mean, while the median remained closer to the rate on typical federal funds transactions.



Source: Calculated from data supplied by federal funds brokers
 Note: Rates rounded to the nearest basis point; all rates volume-weighted

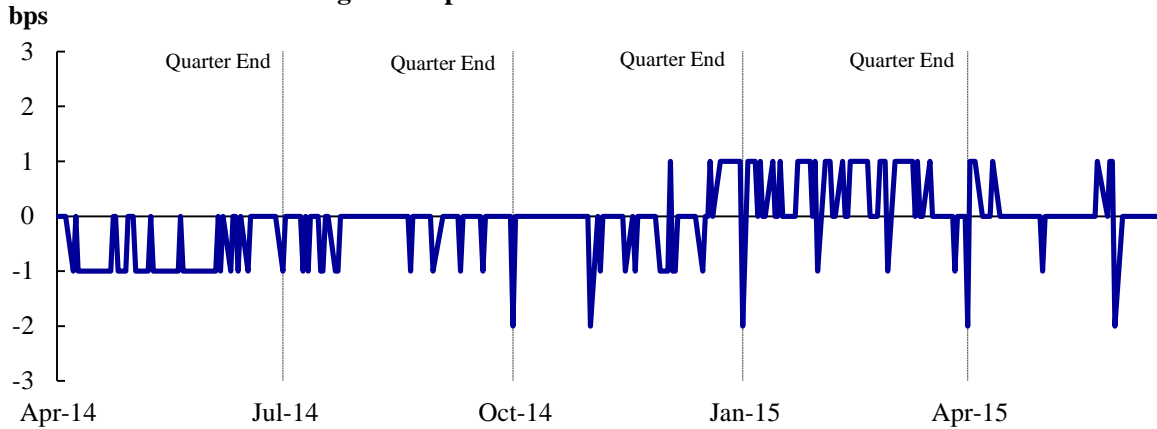
Since the crisis, the differences between the mean and median have generally been small. This is shown in Figure 6, the data for which are obtained from FR 2420. The difference tends to increase on quarter-end dates, when the mean-median spread is about -1.8 points on average. On these days, money market volumes decline and the bulk of trading shifts toward lower rates, while the high-rate tail of the distribution remains relatively steady.

⁷ In this discussion, the “pre-crisis period” is defined as January 2005 to July 2007, the “crisis period” is August 2007 to December 2008, and the “post-crisis period” is January 2009 to June 17, 2015.

⁸ In that period, the average absolute difference between the median and mean was 7.6 basis points, and was greater than or equal to 5 basis points on 45 percent of days.

⁹ These very low-rate tails are less likely to emerge in the future due to the introduction of interest on reserves (IOR) in 2008. Depository institutions generally have little incentive to lend federal funds at rates substantially below the IOR rate.

Figure 6: Spread of Median Rate over Mean Rate

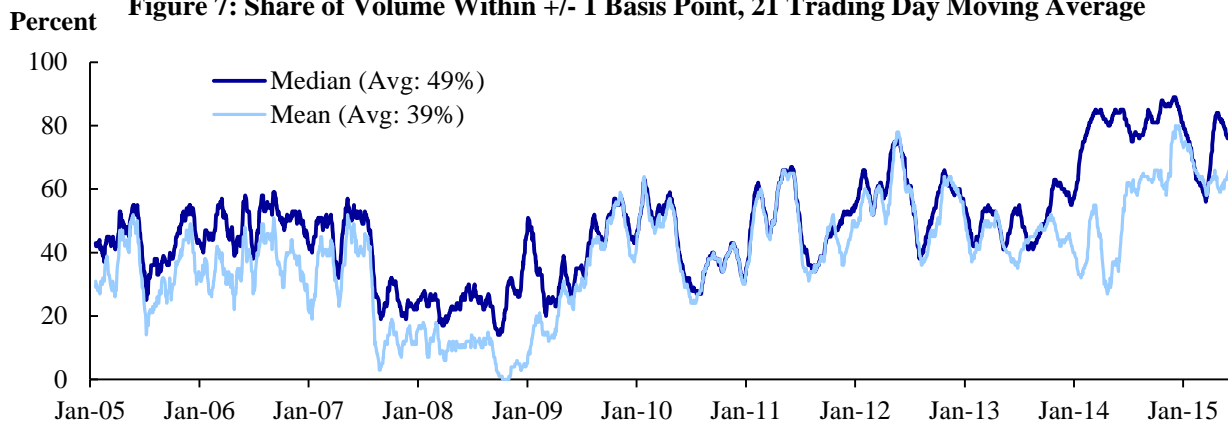


Source: Calculated from FR 2420 data
 Note: Rates rounded to the nearest basis point

Proximity to Typical Activity

Over recent years, the median has almost always been more representative of typical trading activity in the federal funds market, in the sense that a greater share of trading has occurred close to it. This is shown in Figure 7, which presents the share of traded volume that occurred within one basis point in either direction of the median and mean rates.

Figure 7: Share of Volume Within +/- 1 Basis Point, 21 Trading Day Moving Average



Source: Calculated from data supplied by federal funds brokers
 Note: Rates rounded to the nearest basis point. Moving averages of share of volume are rounded to the nearest percent.

2. Promoting the Integrity of the EFR

Because of the federal funds rate’s roles as the FOMC’s policy target rate and as a reference rate in many financial contracts, it is important that the calculation methodology promote the integrity of the rate. In particular, the rate should be robust to the submission of erroneous data.

The already-planned switch in data source to the FR 2420 collection is an important step toward promoting a robust calculation of the EFR. In particular, this data source provides greater visibility into

the transactions underpinning the calculation of the rate, strengthening the ability of the Federal Reserve staff to detect and address misreported data. However, the EFFR must be calculated and published only a few hours after the data is collected, leaving only a short window for real-time reviews. This short review period underscores the importance of incorporating the possibility of invalid data into the selection of a calculation methodology.

One can evaluate the sensitivity of the median and mean to invalid data by simulating the addition of an invalid transaction to see how unusual such a transaction would need to be to alter the calculated mean and median by a given amount, for example, 1 basis point.¹⁰ To alter the calculated level of the rate, the median requires an invalid transaction that is a much more unusual outlier than the mean does on nearly all days since FR 2420 data became available.¹¹ This is because the median usually requires a very large volume on the invalid transaction to cause it to fix at a different value, while the mean can be moved by a trade with a smaller volume and a rate that, while more distant from the true mean, is not especially unusual.

For example, to increase the median by 1 basis point by introducing a single invalid trade each day to the historical FR 2420 data would have, on average, required a transaction of about \$23 billion at a rate at least 1 basis point higher than the median rate.¹² Such an unusually large transaction would be a notable outlier as it is close to half of average daily reported volume over the period. In contrast, the transactions required to alter the mean are on average much closer to typical rates and volumes. For example, a 1 basis point increase in the mean would result from an invalid transaction of about \$3 billion on average and a rate about 8 basis points above the median rate on those days. Neither the rate nor the volume on such a transaction would be especially unusual. While the rate and volume on the invalid transaction that are needed to increase or decrease the median or mean are not constant because of daily variation in the rate distribution, the median would have required the introduction of a substantially more unusual outlier transaction to move it up or down on most days.

3. Resiliency to Changes in Federal Funds Activity

The federal funds market has changed notably since the financial crisis, with lower transaction volumes and a somewhat narrower set of market participants.¹³ As there is uncertainty about how the market will evolve in the future, it is desirable that the calculation methodology for the EFFR provide a stable

¹⁰ As noted earlier, the EFFR is reported rounded to the nearest basis point.

¹¹ This can be illustrated in the context of the example shown in footnote 5. The rounded mean rate in that example can be reduced by one basis point by adding an additional \$4 million transaction at 5 basis points. This transaction increases daily volume by 4 percent, and the rate on that transaction, while low, might not be unusual in the context of a federal funds market with significant distributional tails. In contrast, to reduce the reported median by one basis point requires adding a \$21 million transaction, a notably larger size.

¹² These estimates were calculated using FR 2420 transactional data from April 4, 2014 to April 2, 2015.

¹³ See Afonso, Entz and LeSueur, "[Who's Lending in the Fed Funds Market?](#)," December 2, 2013; Afonso, Entz and LeSueur, "[Who's Borrowing in the Fed Funds Market?](#)," December 9, 2013; and "Domestic Open Market Operations During 2014," Box 5 "[Recent Dynamics in the Federal Funds Market.](#)"

and useful measure of conditions in short-term money markets even on days when volumes or the number of transactions are low.¹⁴

One can evaluate the behavior of the median and mean in reduced-volume environments through simulating lower levels of activity based on historical data. Transactions can be randomly selected from historical daily FR 2420 data to reduce market volume by fixed amounts. For each simulated sample of federal funds activity representing a reduced-volume environment, a mean and median can be calculated. Since the mean and median are calculated from the same set of samples, differences between the measures reflect differences in sensitivity to the particular sample drawn.

This analysis finds that the median is less sensitive to low volumes, as the median shows less variation than the mean across samples and is less likely to reach extreme values. This suggests that the median would be likely to more consistently provide a rate that is reflective of market conditions. That said, because there is currently a robust amount of activity in the federal funds market, a substantial decline in volume would likely need to occur for the sensitivity of the mean and median to reduced volumes to become substantially different.

¹⁴ On February 10, 2010, Chairman Ben S. Bernanke [stated](#) that “as a result of the very large volume of reserves in the banking system, the level of activity and liquidity in the federal funds market has declined considerably, raising the possibility that the federal funds rate could for a time become a less reliable indicator than usual of conditions in short-term money markets.”