ONrates12022023

Hammond

2024-04-19

\begin{document}

’’’{r, load environment volatile, echo=FALSE} my_envvolatile<- readRDS(“C:/Users/Owner/Documents/Research/OvernightRates/my_envvolatile.RDS”)

```
Structure of article: IMRAD:
Introduction
Data
Methodology
Results and
Discussion

Conclusion
Acknowledgements
References
Supporting Materials
```

Introduction
Overnight reference rates, the whole money market rates, and the Federal Reserve's policy and adminsi

That they differ strongly in central tendencies, clustering, outliers under different policy
regimes beg we understand the role of monetary shocks and the Fed's preferences for volatility in ma
term interest rate
- complex conditional heteroskedasticity
- fat-tailed innovations
- pronounced autocorrelation patterns

Daily overnight rates include the unsecured rates The effective federal funds rate (EFFR), The
Federal funds market consists of domestic unsecured borrowings by depository institutions from
other depository institutions and certain other entities, primarily government-
sponsored enterprises.
The EFFR is calculated as a volume-weighted median of overnight federal funds transactions.
The OBFR is a measure of wholesale, unsecured, overnight bank funding costs, calculated from
federal funds transactions, Eurodollar transactions, and domestic deposit transactions. The
federal funds rate is the Fed's policy rate. The effective federal funds rate (EFFR) tracks
transactions in the federal funds market. The overnight bank funding rate (OBFR), similar to
the EFFR, is a broad measure of U.S. dollar funding costs for U.S. based banks. The secured
overnight funding rate (SOFR) captures transactions in overnight wholesale funding markets,
the tri-party general collateral rate (TGCR) and over the counter broad general collateral rate
(BGCR).

Transactions in the tri party market TGCR is centrally cleared. The BGCR is an over the counter tran
versus-Payment (DVP) service offered by the Fixed Income Clearing Corporation (FICC). The FICC trades

The distributions of daily rates rates and transactions transactions, billions of dollars, change dra
Volatility, as measured by the interquartile range (IQR), the 75th percentile - the 25 percentile of

%FIND TABLE
%(Figure \ref{fig:samplechar}).

Reserves went through a full expansion-contraction cycle from 2010 to late 2019 and expanded
again in early 2020, ranging from $\$$8 trillion (2010 and 2019) to $\$$19 trillion (2014 and 2021)
sheet expansions in response to
the 2008 and 2020 crises, as well as the interim normalization period (2015-2019).

To manage the build up in liquidity in reserves after the Great financial Crisis (GFC), the Fed
initiated the policy regime of ample reserves to maintain/manage the Fed Funds rate within its
target range. Its administrative rates comprise a floor system where interest on reserves (IOR)
paid on bank reserves with the Fed are the ceiling and the overnight reverse repurchase rate
(ONRRP rate) is the floor. The Fed or FOMC also temporarily intervenes in repurchase (repo) and
reverse repo to offset high frequency liquidity shocks to keep federal funds rate close to target.

In addition, there has been a dramatice increase in funding through repo and wholesale money market r
Party General Collateral Rate (TGCR), the base layer of repos, is a measure of rates on overnight, sp
counterparty tri-party general collateral repurchase agreement (repo) transactions secured by Treasur

Through repo and reverse repo transactons, the Fed uses the tri party market TGCR for temporary inter
the system or reverse repos to drain reserves. (David Gibbs, Education Director Chicago Mercantile

The level of reserves in the banking system can change either because
1) because funds are transferred between reserves and non-reserve accounts at the Federal
2) changes in the US Treasury account at the Fed
3) The Federal Reserve responds to volatility in the federal funds market by adjusting the reserve
supply to keep the federal funds rate within its target range through these repo and reverse repo ope

By trading securities with banks and other counterparites, Federal Reserve purchases or sales of
assets from banks change the size of the Federal Reserve balance sheet. In a repo transaction,
Federal Reserve purchases securities, adding assets to its balance sheet and issues reserves by
crediting the Federal Reserve accounts of the selling banks. Fed is lends reserves in a reverse
repo transaction. When the Federal Reserve lends to counter parties the Fed sale of securities
lower aggregate reserves as funds are debited from depositor accounts. Fed lending constitutes
a large volume of lending to RRP counterparties MMFs, liquidity.

%[repo increases reserves, lowers FFR reverse repo reverses reserves and raises FFR] [repo means
%dealer deposits (borrowed) reserves collateralized by UST securities?].

This paper describes the dynamics of these rates. A proposed model of volatility to follow, will iden

Recent literature
I summarize findings from the literature of how the Federal Reserve Bank adjustment of reserves affec
Work in this area provide evidence of key characteristics of the FFR - time varying volatility or aut

Hamilton (1996) examine the volatility in the Federal Funds market. adapting Nelson's (1991) EGARCH m
market purchase to smooth out small fluctuations in the FFR, rather than interday arbitration. A smal

Piazzesi (2005) constructs a continuous-time model of the joint distribution of bond yields and the i
run forecast of the economy. Both Federal Reserve and financial markets watch and depend on bond yiel
based information may underlie the FOMC's policy decisions and describes Fed policy better than Taylo

She observes, high-frequency data in a linear-quadratic jump-diffusion model provides information abo

The short informational lag before Fed's policy decision, information available right before the FOMC
frequency policy rule and the associated forecast errors into policy shocks. based on yield curve inf
free bond market.

Findings:
 1) latent factors
 the target set by the Fed is an observable factor in the model and provides a clean measure of the s
 2) Second, the estimated response of yields to policy shocks is strong and slowly declines only with
 3) The estimated policy rule describes the Fed as reacting to information contained in the yield cur
run forecast of the economy.

* The estimated policy rule displays interest rate smoothing: the target level is autocorrelated.
* The rule also displays policy inertia: the Fed only partially adjusts the target to its desired rat

* yield data summarize market expectations of future target moves. These market expectations are
based on a host of variables that are omitted from other rules.
yield data are available at higher frequencies and are less affected by

measurement errors than macroeconomic variables.
The model demonstrated the policy inertia, the tendency to continue same policy changes.

(Andersen, Benzoni,Lund, 2004) model the U.S. short-term interest rate 3 month Tbill with a three-
factor jump-diffusion model. The model includes a time-varying mean reversion factor, a stochastic vo
term interest rate is characterized by complex conditional heteroskedasticity, fat-
tailed innovations, and pronounced autocorrelation patterns. Stochastic volatility is critical for
reversion of the short rate around a highly persistent time-varying central tendency process. Jumps a

The mean drift may be indicative of slowly evolving inflationary expectations (Gara horiz?), time-
variation in the required real interest rate, or both.

Bertolini, Bertola, Prati () and Gara () and Benzoni observe that the effect of Fed interventions on
* declines in high rate regimes
* rises end of quarter, end of year
* falls before holidays, rises day after
* other observations:
    - TS properties. Many rate changes of half percent or more (annualized), and outliers. Volatility

Bertolini, Bertola, Prati (2004) model of FFR volatility seeks to isolate Fed preferences for offsett
They note the immediate response of other key short rates to monetary policy and other shocks. Overni

Gara Afonso, Kyungmin Kim, Antoine Martin, Ed Nosal, Simon Potter, and Sam Schulhofer-
Wohl. Monetary policy implementation with an ample supply of reserves (2020) derive a function of res

Reserve demand, portrayed in realized rates against realized reserves, is nonlinear, downward-
sloping reflecting a negative relation ship between prices and quantities. The slope oof the demand c

\emph{Vertical shift}
Policy changes shift the curve up and down by moving its lower bound. Increases (descreases) in the (
IORB?) IORB rate shift the demand curve down (up by changing the banks' opportunity cost of lending i
\emph{Horizontal shift}
Low frequency horizontal shifts in the demand function reflect sensitivity of rates to shocks to rese
(1): for every level of the federal funds rate, they imply an increase in the quantity of aggregate
reserves demanded by the banking system. As a result of these shifts, the level of reserves at which
the curve stops being flat and start displaying a negative slope may have moved over time.

The visible negative correlation between quantities (reserves) and prices (federal funds rates) sugge

ISSUES
Bertolini, Bertola, Prati () and Gara () and Benzoni observe that the effect of Fed interventions on
* declines in high rate regimes
* rises end of quarter, end of year
* falls before holidays, rises day after
* other observations:
    - TS properties. Many rate changes of half percent or more (annualized), and outliers. Volatility
    - Mean reverision versus dispersion?

Citations
Adam Copeland | Darrell Duffie | Yilin (David) Yang. Reserves Were Not So Ample After All. July 2021
JEL classification: G14, D47, D8

James D. Hamilton. The Daily Market for Federal Funds. February 1996. Journal of Political Economy, V
Stable URL: \url{https://www.jstor.org/stable/2138958}
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Piazzesi, Monika. Bond Yields and the Federal Reserve. April 2005. Journal of Political Economy, Volu
344.

Gara Afonso, Kyungmin Kim, Antoine Martin, Ed Nosal, Simon Potter, and Sam Schulhofer-
Wohl. Monetary policy implementation with an ample supply of reserves. January, 2020. Federal Reserve
02
\url{https://doi.org/10.21033/wp-2020-0}

Bertolini.L, Bertola, Prati. Day-To-DaY_Monetary Policy and the Volatility of the Federal Funds Inter

Torben Gustav Andersen, Luca Benzoni,Jesper Lund. Stochastic volatility, mean drift, and jumps in the
term interest rate. January 2004

%@article{article,
%author = {Andersen, Torben and Benzoni, Luca and Lund, Jesper},
%year = {2004},
%month = {01},
%pages = {},
%title = {Stochastic volatility, mean drift, and jumps in the short-term interest rate}
%}

Monetary policy during the sample period 2016-2023
* my shocks (FFR changes under episodes)
* Romer and Romer shocks
* other external shocks to these markets

In work to follow, the goal is to show how these shocks, changes in monetary policy (Table \ref{table

Before the financial crisis of 2008, policy was typically based on adjusting the scarcity value of a
2023. The QE1, QE2, and QE3 asset purchases [PURPOSE] challenged the bank's ability to control short-
term interest rates. Asset purchases under QE resulted in central banks changing their overall framew
term interest rates.

Policy changes include FOMC reference rate changes from Libor sot SOFR, paying depositing banks inte

FOMC rate changes occurred during the six year period of our sample 2016-2022 (Table \ref{table:FOMC

In 2018 the FOMC adopted target rates, In 2019, the FOMC abandoned active management of scarce reserv

On October 1, 2008, Congress gave the Fed the power to pay interest on reserves (IOR) to help control

The IOR is the Fed's principal tool for interest rate control. It sets a ceiling on the FFR. In 2013,

Each repo transaction is economically similar to a loan collateralized by securities,interest" paid o

The reverse repo facility, the ON RRP facility, is available to a wide range of money market lenders.
Under this ample reserves regime The Federal Reserve manages the the policy rate, the Federal Funds r

In the ample reserves regime introduced in 2019, the Fed adjusts administrative rates, the IOR and th

In this corridor system, the interest on reserves (IOR) is the ceiling, the overnight reverse repo p

```
Similarly, no bank should be borrow at a higher rate than the ONRRP. No bank should lend at a lower r
bank financial institutions should be unwilling to invest funds in private markets below the ONRRP. O

In the ample reserves regime. the administered rates constitute a "floor" system to manages the FFR w

The administered rates, the IOR and the ON RPP,  along with an ample supply of reserves, created a co
No bank should be borrow at a higher rate than the ONRRP. Banks and non-bank financial institutions s

Under the Ample Reserves policy, the Federal Reserve manages the FFR within its desired range in a "f
term repurchase and reverse repurchase agreements. These Short-term repurchase and reverse repurchase
to-day trading in the Federal Funds market.


%\url{https://libertystreeteconomics.newyorkfed.org/2022/01/how-the-feds-overnight-
reverse-repo-facility-w%orks/}
%How to cite this post:
%Gara Afonso, Lorie Logan, Antoine Martin, William Riordan, and Patricia Zobel, "How the Fed's Overni
the-feds-overnight-reverse-repo-facil%ity-works/}.

FOMC rates changes, monetary regimes, and events over the four year period, 2018-
2023 (Table \ref{table:FOMCratechanges}) include changes in the Fed funds rate and the administered r

March 3, 2020: Citing "evolving risks to economic activity" from the coronavirus outbreak, the Fed he
March 11, 2020: The World Health Organization (WHO) declares Covid-19 a global pandemic
March 15, 2020: In another emergency meeting, the Fed slashes rates to zero (a range of 0-0.25%) and
March 16, 2020: The Dow falls 12.9%, triggering a stock market crash. It would go on to lose a total
April 2020: U.S. unemployment reaches an average of 14.7%, its highest level since 1948, although job
August 28, 2020: At an economic symposium in Jackson Hole, the Fed announces a new strategy that call
based and inclusive goal"
July 28, 2021: The Fed holds rates steady at near-zero levels, labelling rising inflation a "transito
January 26, 2022: Powell states that "labor market conditions are consistent with maximum employment"
February 24, 2022: Russia invades Ukraine
March 16, 2022: The Fed makes its first interest rate increase since 2018, raising rates by 0.25% to
May 5, 2022: The Fed increases interest rates 0.50% to 0.75-1.00% and states that it anticipates ongo
June 2022: Inflation, as measured by the Consumer Price Index (CPI), peaks at 9.1%
June 16, 2022: The Fed raises rates 0.75% to 1.50-1.75%
July 28, 2022: The Fed hikes rates another 0.75% to 2.25-2.50%
September 22, 2022: The Fed delivers another 0.75% rate increase, bringing rates to 3.00-3.25%
November 3, 2022: It increases rates by 0.75% to 3.75-4.00%, adding that it is "prepared to adjust th
December 15, 2022: This time, the Fed raises rates by 0.5% to 4.25-4.50%
February 2, 2023: It adds another 0.25% increase to 4.50-4.75%
March 23, 2023: The Fed increases interest rates by an additional 0.25% to 4.75-5.0% and launches the
rate risk
May 4, 2023: The Fed hikes another 0.25% to 5.00-5.25%
July 27, 2023: The Fed delivers its final 0.25% increase of 2023, bringing rates to 5.25-5.50%
-->

library(xtable)

# Create a data frame with your table data
%fomc_data <- data.frame()
%fomc_table <- xtable(fomc_data)
%print(fomc_table, include.rownames = FALSE)

\begin{table}[h!]
```

```
\centering
\begin{tabular}{c c c}
\hline
FOMC rates changes \\
%Date & Change &(bps)   & Federal Funds Rate (pct) \\ [0.5ex]
 \hline\hline
\textbf{2015 to 2018: Returning to Normalcy} & \\
Date & Change (bps) & Federal Funds Rate (pct) \\ [0.5ex]
\hline
20-Dec-18 &  25 &       2.25 to 2.50\\
Sept. 27, 2018 &        25 &        2.0 to 2.25\\
Jun. 14, 2018&      25 &        1.75 to 2.0\\
22-Mar-18 &     25&     1.50 to 1.75\\
Dec. 14, 2017 &     2&  5   1.25 to 1.50\\
15-Jun-17&      25&     1.00 to 1.25\\
16-Mar-17&      25 &        0.75 to 1.00\\
Dec. 15, 2016 &     25 &        0.5 to 0.75\\
Dec. 17, 2015 &     25&     0.25 to 0.50\\
\hline
\textbf{2019  Mid-Cycle Adjustment} & \\
Date & Change &(bps)    & Federal Funds Rate (pct) \\ [0.5ex]
\hline
31-Oct-19 &     -25 &   1.50 to 1.75\\
Sept. 19, 2019&     -25&        1.75 to 2.0\\
Aug. 1, 2019&       -25 & 2.0 to 2.25\\
\hline
\textbf{2020 Coping with Covid} & \\
Date & Change &(bps)    & Federal Funds Rate (pct) \\ [0.5ex]
\hline
16-Mar-20&      -25&        2.000 to 1.25\\
 0.5% to 1.0-1.25%
3-Mar-20&       -50&        1.0 to 1.25\\
\hline
\textbf{2022 Taming Inflation} & \\
Date & Change &(bps)    & Federal Funds Rate (pct) \\ [0.5ex]
\hline
15-Dec-22&      50&     4.25 to 4.50\\
02-Nov-22&      75&     3.75 to 4.00\\
21-Sep-22&      75&     3.00 to 3.25\\
27-Jul-22&      75&     2.25 to 2.5\\
16-Jun-22&      75&     1.5 to 1.75\\
05-May-22&      50&     0.75 to 1.00\\
17-Mar-22&      25&     0.25 to 0.50\\
15-Dec-22$    50&   4.25 to 4.50\\
27-Jul-23&    25&   5.25-5.50\\
04-May-23&    25&   5.00 to 5.25\\
23-Mar-23&    25&   4.75 to 5.00\\
02-Feb-23&    25&   4.5 to 4.75\\
\end{tabular}
\caption{FOMC rates changes 2018 to 2022}
\label{table:FOMCratechanges}
\end{table}
```

Events:

1) repo rate spike
    9/16/2019 Repo spike SOHR 2.42 +13 over 9/15, EFFR 2.23 +11
    9/17/2019 Repo spike   SOFR 5+   EFFR 2.3
\url{https://www.federalreserve.gov/econres/notes/feds-notes/what-happened-in-money-markets-in-september-2019-20200227.html}
On Monday, September 16, SOFR printed at 2.43 percent, 13 basis points higher than the previous business day. With pressures in the repo market spilling over into the fed funds market, the EFFR printed at 2.25 percent, 11 basis points above the Friday print and at the top of the FOMC's target range. On September 17, the EFFR moved above the top of the target range to 2.3 percent and the SOFR increased to above 5 percent.

2) Mar 10-18 2020 Dash for cash
    3/8/2020 0:00 subtract 5 from coordinate
    3/15/2020 0:00
The COVID-19 Pandemic Caused Market Disruptions across Sovereign Bond Markets
At the start of the COVID-19 pandemic in late February 2020, and in response to the economic repercussions of impending lockdown measures, investors began to demand higher-quality,
safe assets. In particular, they shifted their portfolios toward sovereign bonds, and the resulting buying pressure drove sovereign yields to decline broadly. As the crisis intensified in March 2020, however, investors' demand for cash surged, leading to selling pressure on sovereign bonds and therefore increases in their yields. This down-and-up pattern in yields is illustrated for ten-year U.S., German, U.K., and Japanese bonds in the chart below.

March 15, 2020 On March 15, 2020, the Fed shifted the objective of QE to supporting the economy. It said that it would buy at least $\$$500 billion in Treasury securities and $\$$200 b guaranteed mortgage-backed securities over "the coming months."
 - 3/22/2020 March 23, 2020, it made the purchases open-ended, saying it would buy securities "in the amounts needed to support smooth market functioning and effective transmission of monetary policy to broader financial conditions," expanding the stated purpose of the bond buying to include bolstering the economy.

June 2020 - In June 2020, the Fed set its rate of purchases to at least $\$$80 billion a month in Treasuries and $\$$40 billion in residential and commercial mortgage-backed
securities until further notice.

 December 2020 slow: The Fed updated its guidance in December 2020 to indicate it would slow these purchases once the economy had made "substantial further progress" toward the Fed's goals of maximum employment and price stability.
 - November 2021 taper: In November 2021, judging that test had been met, the Fed began tapering its pace of asset purchases by $\$$10 billion in Treasuries and $\$$5 billion in MBS each month.
 - December 2021 double taper: At the subsequent FOMC meeting in December 2021, the Fed doubled its speed of tapering, reducing its bond purchases by $\$$20 billion in Treasuries and $\$$10 billion in MBS each month

December 2020 slow purchase
November 2021
December 2021

%Table and figures display changes in the Fed funds rate and the administered rates IOR
% and the reward rate ON RRP
%Table \ref{table:FOMCratechanges} lists FOMC rates changes, monetary regimes, and events

%over the four year period, 2018-2022.

Daily overnight rates --
%Intro
%Observations issues
%Overnight rates are outliers, heteroskedastic, outliers present, and Extreme or high
%volatility of short rates. volatility survives rate the Federal Reserve Bank's (Fed)
%management of of the Federal Funds rate.
%Volatility relative to to prior periods (here daily)
%Outliers
%Rate volatility survives

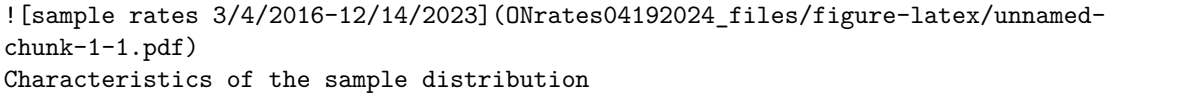
Rates
We examine the time series properties of overnight reference rates and their correspondence
with the Federal Funds rate, the FOMC policy rate from 2016 through 2023.

Time series properties of overnight policy, interbank rates, transactions, and reserves
held at the Federal Reserve

For the sample from 2016 through 2023, all overnight rates closely track the EFFR(Figure \@ref(fig:Da
2022-plot).

The average weighted median for the Effective Federal Funds Rate (EFFR) stands at 157 basis points (p
Party General Collateral Rate (TGCR), the Broad General Collateral Rate (BGCR), and Secured Overnight

see Figure \@ref(fig:sample rates 3/4/2016-12/14/2023)



Characteristics of the sample distribution
The rate data from the Federal Reserve Data Download Program are average volume weighted medians and

The median rather than the mean better represent daily rates since the data have outliers or extreme

Fed policy changes are visible in Vertical shifts of the series.
Rates increase steadily from _ basis points during normalcy from March 2016 through July 2019.In 2019

Median rates in the sample cluster around the EFFR at 157 bp, TGCR and BGCR 132.83 and 132.84, SOFR
156.15, an ICR of 1.56 basis points, 1.615034, the TGCR and BGCR an even tighter range under one bp,
132.5059

Outliers that make up two percent of the data, the highest minus lowest rates are 23.36, 13.86, 16.11

Daily volume in whole rates TBGR and BGCR almost quadruple the transactions in the EFFR: 78.91262, 2

<!--
              EFFR   TGCR   BGCR   SOFR
Rate   156.9688 132.8314 132.8482 134.0756
Volume   78.91262 296.9484 311.2315 754.3664
Upper target 170.5161 NA   NA   NA

```
Lower target  145.5161 NA       NA       NA
Percentile_01 153.07   124.8942 125.0746 NA
Percentile_25 156.1502 132.3551 132.3679 NA
Percentile_75 157.7067 133.2718 133.325  129.022
Percentile_99 169.0629 138.7547 141.1865 132.5059
-->



% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:16 2024
\begin{table}[ht]
\centering
\begin{tabular}{rrrrr}
  \hline
 & EFFR & TGCR & BGCR & SOFR \\
  \hline
Rate & 156.97 & 132.83 & 132.85 & 134.08 \\
  Volume & 78.91 & 296.95 & 311.23 & 754.37 \\
  Upper target & 170.52 &  &  &  \\
  Lower target & 145.52 &  &  &  \\
  Percentile\_01 & 153.07 & 124.89 & 125.07 & 129.02 \\
  Percentile\_25 & 156.15 & 132.36 & 132.37 & 132.51 \\
  Percentile\_75 & 157.71 & 133.27 & 133.32 & 136.70 \\
  Percentile\_99 & 169.06 & 138.75 & 141.19 & 143.53 \\
   \hline
\end{tabular}
\end{table}
% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:16 2024
\begin{table}[ht]
\centering
\begin{tabular}{rrrr}
  \hline
EFFR & TGCR & BGCR & SOFR \\
  \hline
156.97 & 132.83 & 132.85 & 134.08 \\
  78.91 & 296.95 & 311.23 & 754.37 \\
  170.52 &  &  &  \\
  145.52 &  &  &  \\
  153.07 & 124.89 & 125.07 & 129.02 \\
  156.15 & 132.36 & 132.37 & 132.51 \\
  157.71 & 133.27 & 133.32 & 136.70 \\
  169.06 & 138.75 & 141.19 & 143.53 \\
   \hline
\end{tabular}
\end{table}
As shown in Figure \@ref(fig:sampleplot_characteristics), the relationship is evident. Table


(see Figure \@ref(fig:Overnight rates boxplot)

(see Figure \@ref(fig:sample period 3/4/2016-12/14/2023)

![EFFR Key percentiles during sample period 3/4/2016-12/14/2023](ONrates04192024_files/figure-
latex/unnamed-chunk-2-1.pdf)
```

The interquartile range (IQR), and range better describe distribution rate data With its extreme val

The range is the spread of the data from the lowest to the highest value in the distribution. A commo
\url{https://statisticsbyjim.com/basics/interquartile-range/}

See (\@ref(tab:sampletable_metrics) provides a summary of the data.

```
% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:17 2024
\begin{table}[ht]
\centering
\begin{tabular}{lrrrr}
  \hline
Category & Median & IQR & RANGE & VOLUME \\
  \hline
EFFR & 156.97 & 1.56 & 15.99 & 78.91 \\
  TGCR & 132.83 & 0.92 & 13.86 & 296.95 \\
  BGCR & 132.85 & 0.96 & 16.11 & 311.23 \\
  SOFR & 134.08 & 4.20 & 14.51 & 754.37 \\
   \hline
\end{tabular}
\end{table}
```

The average weighted median for the EFFR during the sample is 157 basis points (pb). The average weig
134 bp. Daily transaction volume in SOFR (billions of dollars) is around 754 billion. The money mark

The interquartile range (IQR) indicated half the data are clustered tightly around median rates. Half

Estimating moments of the data show overnight rates are highly skewed with fatter tails.

The interquartile range for the money market rates TGCR and BGCR show 50 percent of the data are clos

The range of the data, the 99th minus the first percentile, is more sensitive to outliers. The range

volatility
I describe volatility as 1) log percent changes in rates since data (see Figure \@ref(fig:volatility

From 2016 to 2020, the percent change in overnight rights, although varying daily, is in the range of

%(\url{https://www.investopedia.com/terms/h/heteroskedasticity.asp})
%Heteroskedasticity often arises in two forms: conditional and unconditional. Conditional .
%? Do my plots of log percent changes, and standard deviation of log percent changes serve

%Mean reversion
%Benzoni identify mean reversion around a central tendency. The stochastic mean allows a relatively
reversion of the short rate around a highly persistent time-varying central tendency process.
%Jumps are integral to the quality of fit and relieve the stochastic volatility factor from accommoda

(see Figure \@ref(fig:volatility log percent change)

```
![volatility Percent change Daily rates 2016-2023](ONrates04192024_files/figure-
latex/unnamed-chunk-3-1.pdf)

(see Figure \@ref(fig:stdev volatility 5day)



## Episodes that suggest different policy regimes
The vertical shifts in rate data from 2016 t0 2023 suggest different episodes of Fed policy regimes.
The following policy episodes are identified from visual inspection of the data and the corresponsing

The following episodes that may correspond with differing policy regimes or external shocks (Figure \
2023-plot):

* normalcy   3/4/2016       7/31/2019
* mid cycle adjustment 8/1/2019 - 10/31/2019 737660
* covid 11/1/2019       3/16/2020
* zlb         3/17/2020- 3/16/2022
* Taming inflation 03/17/2022 - 12/14/2023


%PRESENT CHAR AND STATS JOINTLY AS BELOW
%Table \@ref(tab:combinedtable_characteristics)
%Table \@ref(tab:combinetable_statistics)




## episode characteristics
<!--
'data.frame':   1957 obs. of  9 variables:
 $ sdate            : Date, format: "2016-03-04" "2016-03-07" "2016-03-08" "2016-03-
09" ...
 $ EFFR             : num  36 36 36 36 36 36 36 37 37 37 ...
 $ VolumeEFFR       : num  75 72 72 75 72 68 67 67 63 63 ...
 $ TargetUe         : num  50 50 50 50 50 50 50 50 50 50 ...
 $ TargetDe         : num  25 25 25 25 25 25 25 25 25 25 ...
 $ Percentile01_EFFR: num  34 34 32 34 35 35 35 35 35 36 ...
 $ Percentile25_EFFR: num  36 36 36 36 36 36 36 36 36 36 ...
 $ Percentile75_EFFR: num  37 37 37 37 37 37 37 37 37 37 ...
 $ Percentile99_EFFR: num  52 50 50 52 75 50 50 50 50 50 ...)
Table \@ref(tab:norm_characteristics) provides a summary of the data.
-->

The sample
The average weighted median for the EFFR during the sample is 157 basis points (pb). The average weig
134 bp. Daily transaction volume in SOFR (billions of dollars ) is around 754 billion. The money mark

The interquartile range (IQR) indicated half the data are clustered tightly around median rates. Half

Estimating moments of the data show overnight rates are highly skewed with fatter tails.

The interquartile range for the money market rates TGCR and BGCR show 50 percent of the data are clos
```

The range of the data, the 99th minus the first percentile, is more sensitive to outliers. The range

From 2016 to 2020, the percent change in overnight rights, although varying daily, is in the range of

Among the episodes, the average weighted median for the EFFR. respectively the five episodes normalcy

Daily transaction SOFR volumes, 385.64 (billions of dollars), dwarf the similar volume in the other r

The interquartile range (IQR) indicated half the data are clustered tightly around median rates. Half

Estimating moments of the data show overnight rates are highly skewed with fatter tails.

The interquartile range for SOFR exceed that for the EFFR and the money market rates TGCR and BGCR; f

The range of the data, the 99th minus the first percentile, shows extensive to outliers. The smalles

From 2016 to 2020, the percent change in overnight rights, although varying daily, is in the range of

<!--
episodeschar

	EFFR	TGCR	BGCR	SOFR
Rate	133.789044	83.829837	83.835664	84.784382
Volume	75.863636	158.525641	166.420746	350.220280
Upper target	143.094406	NA	NA	NA
Lower target	118.094406	NA	NA	NA
Percentile_01	129.376457	79.883450	79.966200	81.437063
Percentile_25	133.326340	83.438228	83.452214	83.547786
Percentile_75	134.546620	83.656177	83.682984	86.848485
Percentile_99	147.023310	85.503497	88.441725	89.968531
Rate	200.093750	206.296875	206.343750	208.218750
Volume	66.843750	466.218750	492.468750	1151.000000
Upper target	212.890625	NA	NA	NA
Lower target	187.890625	NA	NA	NA
Percentile_01	192.078125	191.656250	191.796875	196.468750
Percentile_25	197.250000	205.625000	205.625000	206.000000
Percentile_75	201.906250	206.921875	206.984375	216.531250
Percentile_99	209.750000	214.359375	225.796875	237.734375
Rate	150.461538	148.637363	148.637363	151.186813
Volume	71.703297	401.736264	423.186813	1085.604396
Upper target	168.956044	NA	NA	NA
Lower target	143.956044	NA	NA	NA
Percentile_01	145.802198	142.076923	142.296703	145.615385
Percentile_25	149.527473	148.472527	148.472527	148.714286
Percentile_75	151.879121	148.780220	148.890110	156.087912
Percentile_99	157.516484	153.285714	158.318681	165.076923
Rate	8.085149	4.586139	4.588119	5.409901
Volume	68.968317	353.603960	376.318812	943.722772
Upper target	25.000000	NA	NA	NA
Lower target	0.000000	NA	NA	NA
Percentile_01	5.069307	2.079208	2.051485	1.570297
Percentile_25	7.130693	4.520792	4.526733	3.920792
Percentile_75	8.671287	4.645545	4.673267	6.970297
Percentile_99	12.401980	13.291089	13.910891	16.011881
Rate	368.601367	362.141230	362.195900	364.066059
Volume	99.564920	455.915718	469.753986	1199.936219

```
Upper target  385.649203         NA         NA          NA
Lower target  360.649203         NA         NA          NA
Percentile_01 365.448747 340.849658 341.457859  355.364465
Percentile_25 367.562642 360.990888 361.013667  362.034169
Percentile_75 369.177677 364.255125 364.375854  367.712984
Percentile_99 388.813212 373.123007 374.797267  376.717540

episodesstats
      Category     Median        IQR     RANGE     VOLUME
EFFR      EFFR 133.789044  1.2202797 17.646853   75.86364
TGCR      TGCR  83.829837  0.2179487  5.620047  158.52564
BGCR      BGCR  83.835664  0.2307692  8.475524  166.42075
SOFR      SOFR  84.784382  3.3006993  8.531469  350.22028
EFFR1     EFFR 200.093750  4.6562500 17.671875   66.84375
TGCR1     TGCR 206.296875  1.2968750 22.703125  466.21875
BGCR1     BGCR 206.343750  1.3593750 34.000000  492.46875
SOFR1     SOFR 208.218750 10.5312500 41.265625 1151.00000
EFFR2     EFFR 150.461538  2.3516484 11.714286   71.70330
TGCR2     TGCR 148.637363  0.3076923 11.208791  401.73626
BGCR2     BGCR 148.637363  0.4175824 16.021978  423.18681
SOFR2     SOFR 151.186813  7.3736264 19.461538 1085.60440
EFFR3     EFFR   8.085149  1.5405941  7.332673   68.96832
TGCR3     TGCR   4.586139  0.1247525 11.211881  353.60396
BGCR3     BGCR   4.588119  0.1465347 11.859406  376.31881
SOFR3     SOFR   5.409901  3.0495050 14.441584  943.72277
EFFR4     EFFR 368.601367  1.6150342 23.364465   99.56492
TGCR4     TGCR 362.141230  3.2642369 32.273349  455.91572
BGCR4     BGCR 362.195900  3.3621868 33.339408  469.75399
SOFR4     SOFR 364.066059  5.6788155 21.353075 1199.93622
-->


\@ref(tab:normtable_char) provides a summary of the data.

% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:19 2024
\begin{table}[ht]
\centering
\begin{tabular}{rrrrrl}
  & EFFR & TGCR & BGCR & SOFR & Episode \\
  \hline
Rate\_1 & 133.79 & 83.83 & 83.84 & 84.78 & $\backslash$hline Normalcy $\backslash$hline \\
  Rate\_2 & 75.86 & 158.53 & 166.42 & 350.22 &  \\
  Rate\_3 & 143.09 &  &  &  &  \\
  Rate\_4 & 118.09 &  &  &  &  \\
  Rate\_5 & 129.38 & 79.88 & 79.97 & 81.44 &  \\
  Rate\_6 & 133.33 & 83.44 & 83.45 & 83.55 &  \\
  Rate\_7 & 134.55 & 83.66 & 83.68 & 86.85 &  \\
  Rate\_8 & 147.02 & 85.50 & 88.44 & 89.97 &  \\
   \hline
Rate\_11 & 200.09 & 206.30 & 206.34 & 208.22 & $\backslash$hline Adjustment $\backslash$hline \\
  Rate\_21 & 66.84 & 466.22 & 492.47 & 1151.00 &  \\
  Rate\_31 & 212.89 &  &  &  &  \\
  Rate\_41 & 187.89 &  &  &  &  \\
  Rate\_51 & 192.08 & 191.66 & 191.80 & 196.47 &  \\
  Rate\_61 & 197.25 & 205.62 & 205.62 & 206.00 &  \\
```

```
  Rate\_71 & 201.91 & 206.92 & 206.98 & 216.53 &  \\
  Rate\_81 & 209.75 & 214.36 & 225.80 & 237.73 &  \\
   \hline
Rate\_12 & 150.46 & 148.64 & 148.64 & 151.19 & $\backslash$hline Covid $\backslash$hline \\
  Rate\_22 & 71.70 & 401.74 & 423.19 & 1085.60 &  \\
  Rate\_32 & 168.96 &  &  &  &  \\
  Rate\_42 & 143.96 &  &  &  &  \\
  Rate\_52 & 145.80 & 142.08 & 142.30 & 145.62 &  \\
  Rate\_62 & 149.53 & 148.47 & 148.47 & 148.71 &  \\
  Rate\_72 & 151.88 & 148.78 & 148.89 & 156.09 &  \\
  Rate\_82 & 157.52 & 153.29 & 158.32 & 165.08 &  \\
   \hline
Rate\_13 & 8.09 & 4.59 & 4.59 & 5.41 & $\backslash$hline Zero lower bound $\backslash$hline \\
  Rate\_23 & 68.97 & 353.60 & 376.32 & 943.72 &  \\
  Rate\_33 & 25.00 &  &  &  &  \\
  Rate\_43 & 0.00 &  &  &  &  \\
  Rate\_53 & 5.07 & 2.08 & 2.05 & 1.57 &  \\
  Rate\_63 & 7.13 & 4.52 & 4.53 & 3.92 &  \\
  Rate\_73 & 8.67 & 4.65 & 4.67 & 6.97 &  \\
  Rate\_83 & 12.40 & 13.29 & 13.91 & 16.01 &  \\
   \hline
Rate\_14 & 368.60 & 362.14 & 362.20 & 364.07 & $\backslash$hline Inflation $\backslash$hline \\
  Rate\_24 & 99.56 & 455.92 & 469.75 & 1199.94 &  \\
  Rate\_34 & 385.65 &  &  &  &  \\
  Rate\_44 & 360.65 &  &  &  &  \\
  Rate\_54 & 365.45 & 340.85 & 341.46 & 355.36 &  \\
  Rate\_64 & 367.56 & 360.99 & 361.01 & 362.03 &  \\
  Rate\_74 & 369.18 & 364.26 & 364.38 & 367.71 &  \\
  Rate\_84 & 388.81 & 373.12 & 374.80 & 376.72 &  \\
  \end{tabular}
\end{table}


% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:19 2024
\begin{table}[ht]
\centering
\begin{tabular}{rrrrr}
  \hline
 & EFFR & TGCR & BGCR & SOFR \\
  \hline
Rate & 133.79 & 83.83 & 83.84 & 84.78 \\
  Volume & 75.86 & 158.53 & 166.42 & 350.22 \\
  Upper target & 143.09 &  &  &  \\
  Lower target & 118.09 &  &  &  \\
  Percentile\_01 & 129.38 & 79.88 & 79.97 & 81.44 \\
  Percentile\_25 & 133.33 & 83.44 & 83.45 & 83.55 \\
  Percentile\_75 & 134.55 & 83.66 & 83.68 & 86.85 \\
  Percentile\_99 & 147.02 & 85.50 & 88.44 & 89.97 \\
   \hline
\end{tabular}
\end{table}


## episode stats ----------------------------------------------------------
Table \@ref(tab:normtable_metrics) provides a summary of the data.
```

```
% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:19 2024
\begin{table}[ht]
\centering
\begin{tabular}{lrrrr}
  \hline
Category & Median & IQR & RANGE & VOLUME \\
  \hline
EFFR & 133.79 & 1.22 & 17.65 & 75.86 \\
  TGCR & 83.83 & 0.22 & 5.62 & 158.53 \\
  BGCR & 83.84 & 0.23 & 8.48 & 166.42 \\
  SOFR & 84.78 & 3.30 & 8.53 & 350.22 \\
   \hline
\end{tabular}
\end{table}
```

see Figure \@ref(fig:EFFR during normalcy period 3/4/2016-7/31/2019)

0.1 Warning: Removed 271 rows containing missing values (`geom_point()`).

```
![EFFR during normalcy period 3/4/2016-7/31/2019](ONrates04192024_files/figure-
latex/unnamed-chunk-4-1.pdf)
```

The average weighted median for the EFFR during the normalcy period is 124 basis points (pb). The ave
85 bp. Daily transaction volume in SOFR (billions of dollars) is around 350 billion. The money marke
166 billion. Daily trade volume in EFFR is a low 76 billion. The percentiles of rates reflect the s

(see Figure \@ref(fig:EFFR during normalcy period 3/4/2016-7/31/2019-plot)

```
![EFFR during normalcy period 3/4/2016-7/31/2019](ONrates04192024_files/figure-
latex/rates_norm-1.pdf)
```

The interquartile range for the money market rates TGCR and BGCR are 0.22-0,23 bp, smaller than the 1

The range of the data, the 9th ,minus the first percentile, is more sensitive to outliers/ Some 17.65
8.53the money market rates, TGCR, BGCR, and SOFR.

The average weighted median for the EFFR during the nomrmalcy period is 157 basis points (pb). The av
134 bp. Daily transaction volume in SOFR (billions of dollars) is around 754 billion. The money mark

The interquartile range for the money market rates TGCR and BGCR are under 1 bp, smaller than the 1.5

The range of the data, the 9th ,minus the first percentile, is more sensitive to outliers/ Some 14 to

Table \@ref(tab:adjust_characteristics mid cycle adjustment 8/1/2019-10/31/2019) provides a summary

```
% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:21 2024
```

```
\begin{table}[ht]
\centering
\begin{tabular}{rrrrr}
  \hline
 & EFFR & TGCR & BGCR & SOFR \\
  \hline
Rate & 200.09 & 206.30 & 206.34 & 208.22 \\
  Volume & 66.84 & 466.22 & 492.47 & 1151.00 \\
  Upper target & 212.89 &  &  &  \\
  Lower target & 187.89 &  &  &  \\
  Percentile\_01 & 192.08 & 191.66 & 191.80 & 196.47 \\
  Percentile\_25 & 197.25 & 205.62 & 205.62 & 206.00 \\
  Percentile\_75 & 201.91 & 206.92 & 206.98 & 216.53 \\
  Percentile\_99 & 209.75 & 214.36 & 225.80 & 237.73 \\
   \hline
\end{tabular}
\end{table}

Table \@ref(tab:Rate statistics  mid cycle adjustment 8/1/2019-10/31/2019) provides a summary of the

% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:21 2024
\begin{table}[ht]
\centering
\begin{tabular}{lrrrr}
  \hline
Category & Median & IQR & RANGE & VOLUME \\
  \hline
EFFR & 200.09 & 4.66 & 17.67 & 66.84 \\
  TGCR & 206.30 & 1.30 & 22.70 & 466.22 \\
  BGCR & 206.34 & 1.36 & 34.00 & 492.47 \\
  SOFR & 208.22 & 10.53 & 41.27 & 1151.00 \\
   \hline
\end{tabular}
\end{table}

see figure \@ref(fig:EFFR during mid cycle adjustment 8/1/2019-10/31/2019)

![EFFR during mid cycle adjustment 8/1/2019-10/31/2019](ONrates04192024_files/figure-
latex/unnamed-chunk-7-1.pdf)

The average weighted median for all over night rates are tightly clustered around 148.64-
151.18c during covid. The average weighted medians of other money market rates cluster around the med
134 bp. Daily transaction volume in SOFR (billions of dollars ) is around 1086 billion. The money mar
423  billion.  Daily trade volume in EFFR is a low 71.7 billion.  The percentiles of rates reflect th



(see Figure \@ref(fig:EFFR during adjustment period 8/1/2019-10/31/2019-plot)

\```{r, fig.cap= "EFFR during adjustment period  8/1/2019-10/31/2019", rates_adjust}
library(ggplot2)
qadjE<-my_envepisodes$adjust # Using the same data as the first plot
sdate <- as.Date(qadjE[, 1])
data_without_sdate<- qadjE[, -1]
rates=2
```

```
maxr<-max(qadjE[,rates])
minr<-min(qadjE[,rates])

meltrates_adjust <- melt(data.frame(sdate, data_without_sdate), id.vars = "sdate")
meltrates_adjust$variable <- as.factor(meltrates_adjust$variable)
meltrates_adjust$value <- as.numeric(meltrates_adjust$value)
rates_adjust <<- ggplot(meltrates_adjust, aes(x = sdate, y=value, colour=variable, group=variable)) +
  geom_line() +
  labs(caption= "Adjustment  8/1/2019-10/31/2019",x = "", y = "rates basis points (bp) volume (billio
  scale_y_continuous(breaks = seq(minr, maxr, by = 25), limits = c(minr, maxr)) +
  scale_x_date(date_labels = "%Y-%m-%d", date_breaks = "1 month") +  #Specify date format and breaks
  theme_minimal()
print(rates_adjust)
#my_envepisodes$rates_adjust<-rates_adjust
```

The interquartile range for the money market rates TGCR and BGCR are under 1 bp, smaller than the 1.56 bp of the policy rate, EFFR. The SOFR has the largest IQR, some 4.2 bp. The OBFR,designed to track the policy rate. is similar to the EFFR.

The range of the data, the 9th ,minus the first percentile, is more sensitive to outliers/ Some 14 to 16 basis points for the EFFR and the money market rates, TGCR, BGCR, and SOFR.

Table @ref(tab:covidtable_characteristics) provides a summary of the data.

% latex table generated in R 4.3.2 by xtable 1.8-4 package % Fri Apr 19 21:18:22 2024

EFFR	TGCR	BGCR	SOFR
150.46	148.64	148.64	151.19
71.70	401.74	423.19	1085.60
168.96			
143.96			
145.80	142.08	142.30	145.62
149.53	148.47	148.47	148.71
151.88	148.78	148.89	156.09
157.52	153.29	158.32	165.08

Table @ref(tab:Rate statistics covid 11/1/2019-3/16/2020) provides a summary of the data.

% latex table generated in R 4.3.2 by xtable 1.8-4 package % Fri Apr 19 21:18:23 2024

Category	Median	IQR	RANGE	VOLUME
Estatscovid	150.46	2.35	11.71	71.70
Tstatscovid	148.64	0.31	11.21	401.74
Bstatscovid	148.64	0.42	16.02	423.19
Sstatscovid	151.19	7.37	19.46	1085.60

(see Figure @ref(fig:EFFR during covid 11/1/2019-3/16/2020)

```
## Warning: Removed 3 rows containing missing values (`geom_point()`).
```

The average weighted median for the EFFR during the zero lower bound is 8 basis points (pb). The average weighted medians of other money market rates cluster around the median EFFR - TGCR,BGCR and SOFR? 4,6 bp. Daily transaction volume in SOFR (billions of dollars) is around 754 billion. The money market volumes in TGCR and BGCR around 353-376 billion. Daily trade volume in EFFR is a low 69 billion. The percentiles of rates reflect the same clustering around the EFFR and SOFR as do their medians.

(see Figure @ref(fig:EFFR during covid period 11/1/2019-3/16/2020-plot)

"'{r, fig.cap= "EFFR during covid period 11/1/2019-3/16/2020",rates_covid rates=2 library(ggplot2) qcovidE<-my_envepisodes$covid # Using the same data as the first plot data_with-

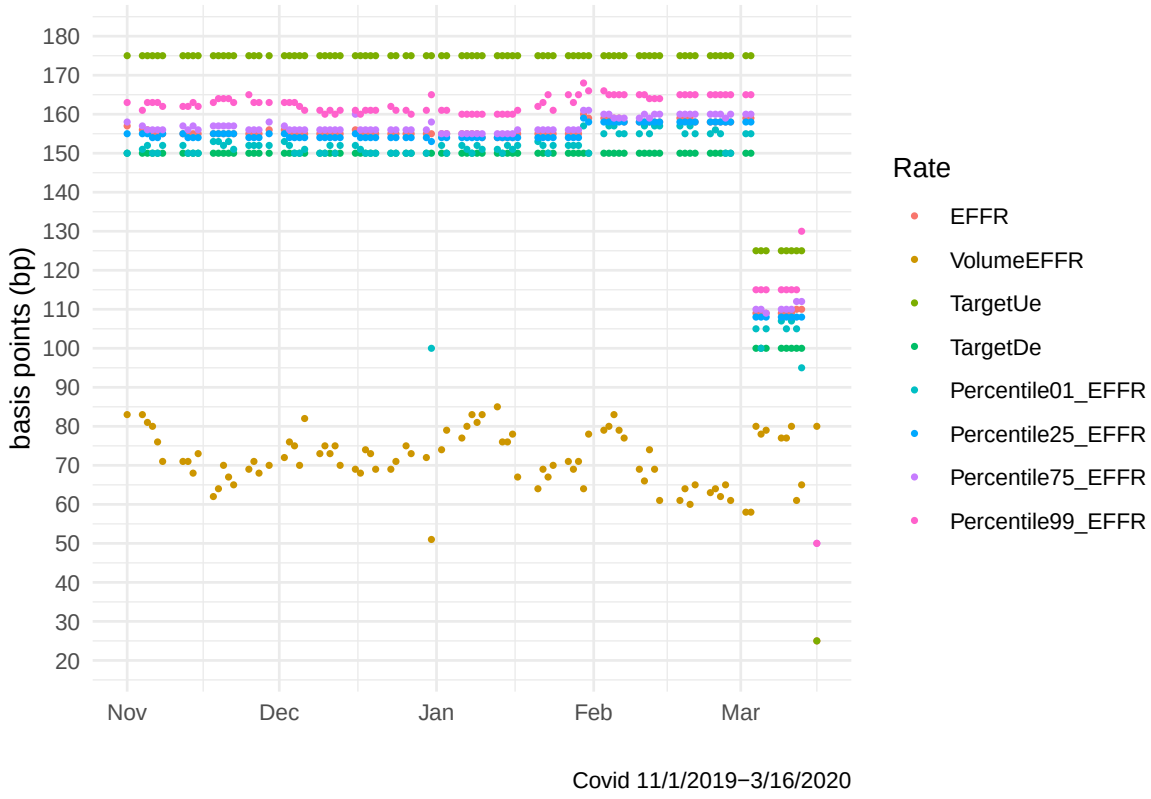


Figure 1: EFFR during covid 11/1/2019-3/16/2020

out_sdate<- qcovidE[, -1] sdate <- as.Date(qcovidE[, 1]) maxr<-max(covid[,2:ncol(covid)]) minr<-min(covid[,2:ncol(covid)])

meltrates_covid <- melt(data.frame(sdate, data_without_sdate), id.vars = "sdate") meltrates_covid$variable <- as.factor(meltrates_covid$variable) meltrates_covid$value <- as.numeric(meltrates_covid$value) rates_covid «- ggplot(meltrates_covid, aes(x = sdate, y = value, colour = variable, group = variable)) + geom_line() + labs(caption="11/1/2019-3/16/2020",x = "", y ="rates basis points (bp) volume (billion dollars)", color ="Rate") + scale_y_continuous(breaks = seq(0, maxr, by = 25), limits = c(0, maxr)) + scale_x_date(date_labels = "%Y-%m-%d", date_breaks = "1 month") + theme_minimal() print(rates_covid) #my_envepisodes$rates_covid<-rates_covid

```
The interquartile range for the money market rates TGCR and BGCR are .12-.15 bp, smaller than the 1.5

The range of the data, the 9th ,minus the first percentile, is more sensitive to outliers, Some 11 to

Table \@ref(tab:zlbtable_characteristics 3/17/2020-3/16/2022) provides a summary of the data.

% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:24 2024
\begin{table}[ht]
\centering
\begin{tabular}{rrrrr}
  \hline
 & EFFR & TGCR & BGCR & SOFR \\
  \hline
Rate & 8.09 & 4.59 & 4.59 & 5.41 \\
  Volume & 68.97 & 353.60 & 376.32 & 943.72 \\
```

```
  Upper target & 25.00 &  &  &  \\
  Lower target & 0.00 &  &  &  \\
  Percentile\_01 & 5.07 & 2.08 & 2.05 & 1.57 \\
  Percentile\_25 & 7.13 & 4.52 & 4.53 & 3.92 \\
  Percentile\_75 & 8.67 & 4.65 & 4.67 & 6.97 \\
  Percentile\_99 & 12.40 & 13.29 & 13.91 & 16.01 \\
   \hline
\end{tabular}
\end{table}


Table \@ref(tab:Rate statistics zero lower bound 3/17/2020-3/16/2022) provides a summary of the data.

% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:24 2024
\begin{table}[ht]
\centering
\begin{tabular}{lrrrr}
  \hline
Category & Median & IQR & RANGE & VOLUME \\
  \hline
Estatszlb & 8.09 & 1.54 & 7.33 & 68.97 \\
  Tstatszlb & 4.59 & 0.12 & 11.21 & 353.60 \\
  Bstatszlb & 4.59 & 0.15 & 11.86 & 376.32 \\
  Sstatszlb & 5.41 & 3.05 & 14.44 & 943.72 \\
   \hline
\end{tabular}
\end{table}

 (see Figure \@ref(fig:EFFR during zero lower bound 3/17/2020-3/16/2022)

![EFFR during zero lower bound 3/17/2020-3/16/2022](ONrates04192024_files/figure-
latex/unnamed-chunk-11-1.pdf)

The average weighted median for the EFFR during the inflation targeting regime is 368 basis points (p
364 bp. Daily transaction volume in SOFR (billions of dollars ) is around 1200 billion. The money mar



(see Figure \@ref(fig:EFFR during zero lower bound (Zlb) period 3/17/2020-3/16/2022

## 0.2 Warning: Removed 517 rows containing missing values (`geom_line()`).

![EFFR during zero lower bound (zlb) period 3/17/2020-3/16/2022](ONrates04192024_files/figure-
latex/rates_zlb-1.pdf)

The interquartile range for the money market rates TGCR and BGCR are 3.26-3.46 bp, smaller than the 1

The range of the data, the 9th ,minus the first percentile, is more sensitive to outliers,  Some 23 b
33.


Table \@ref(tab:Rate characteristics Taming inflation 03/17/2022-12/14/2023) provides a summary of th
```

```
[1] 1519
[1] 1957
% latex table generated in R 4.3.2 by xtable 1.8-4 package
% Fri Apr 19 21:18:26 2024
\begin{table}[ht]
\centering
\begin{tabular}{rrrr}
  \hline
EFFR & TGCR & BGCR & SOFR \\
  \hline
368.60 & 362.14 & 362.20 & 364.07 \\
  99.56 & 455.92 & 469.75 & 1199.94 \\
  385.65 &  &  &  \\
  360.65 &  &  &  \\
  365.45 & 340.85 & 341.46 & 355.36 \\
  367.56 & 360.99 & 361.01 & 362.03 \\
  369.18 & 364.26 & 364.38 & 367.71 \\
  388.81 & 373.12 & 374.80 & 376.72 \\
   \hline
\end{tabular}
\end{table}
```

Table \@ref(tab:Rate characteristics Taming inflation 03/17/2022-12/14/2023) provides a summary of th

```
```{r, tab.cap="Rate characteristics Taming inflation 03/17/2022-12/14/2023",
categories <- c("Estatsinflation", "Tstatsinflation", "Bstatsinflation", "Sstatsinflation",echo=FALSE
library(xtable)
sdate<-sdateinflation
k=5
bgn<-begn[k]
edn<-endn[k]
print(bgn)
print(edn)
inflation<-rrbp[bgn:edn,]
sdateinflation<-sdate[bgn:edn]

qinflationE=quantilesE[bgn:edn,]
qinflationT=quantilesT[bgn:edn,]str
qinflationB=quantilesB[bgn:edn,]
qinflationS=quantilesS[bgn:edn,]

my_envepisodes$sdateinflation <-sdateinflation
my_envepisodes$inflationE <-qinflationE
my_envepisodes$inflationT <-qinflationT
my_envepisodes$inflationB <-qinflationB
my_envepisodes$inflationS <-qinflationS

Estatsinflation <- colMeans(qinflationE[,2:ncol(qinflationE)], na.rm = TRUE)
#Estatsinflation <- colMeans(qinflationO[,2:ncol(qinflationO)], na.rm = TRUE)
Tstatsinflation <- colMeans(qinflationT[,2:ncol(qinflationT)], na.rm = TRUE)
Bstatsinflation <- colMeans(qinflationB[,2:ncol(qinflationB)], na.rm = TRUE)
Sstatsinflation <- colMeans(qinflationS[,2:ncol(qinflationS)], na.rm = TRUE)
print(xtable(charinflation),include.rownames = FALSE)
```
```

```
Tstatsinflation2<-c(Tstatsinflation[1],Tstatsinflation[2], TargetUe=NA, TargetDe=NA,Tstatsinflation[3
Bstatsinflation2<-c(Bstatsinflation[1],Bstatsinflation[2], TargetUe=NA, TargetDe=NA,Bstatsinflation[3
Sstatsinflation2<-c(Sstatsinflation[1],Sstatsinflation[2], TargetUe=NA, TargetDe=NA,Sstatsinflation[3

median_values = c(Estatsinflation[1], Tstatsinflation[1], Bstatsinflation[1], Sstatsinflation[1])
iqr_values = c(Estatsinflation[7] - Estatsinflation[6], Tstatsinflation[5] - Tstatsinflation[4], Bsta
range_values = c(Estatsinflation[8] - Estatsinflation[5], Tstatsinflation[6] - Tstatsinflation[3], Bs
volume_values = c(Estatsinflation[2], Tstatsinflation[2], Bstatsinflation[2], Sstatsinflation[2])
inflationstats <- data.frame(Category = categories, Median = median_values, IQR = iqr_values, RANGE=r
print(xtable(inflationstats),include.rownames = FALSE)
```

(see Figure @ref(fig:EFFR during Taming inflation 03/17/2022-12/14/2023)

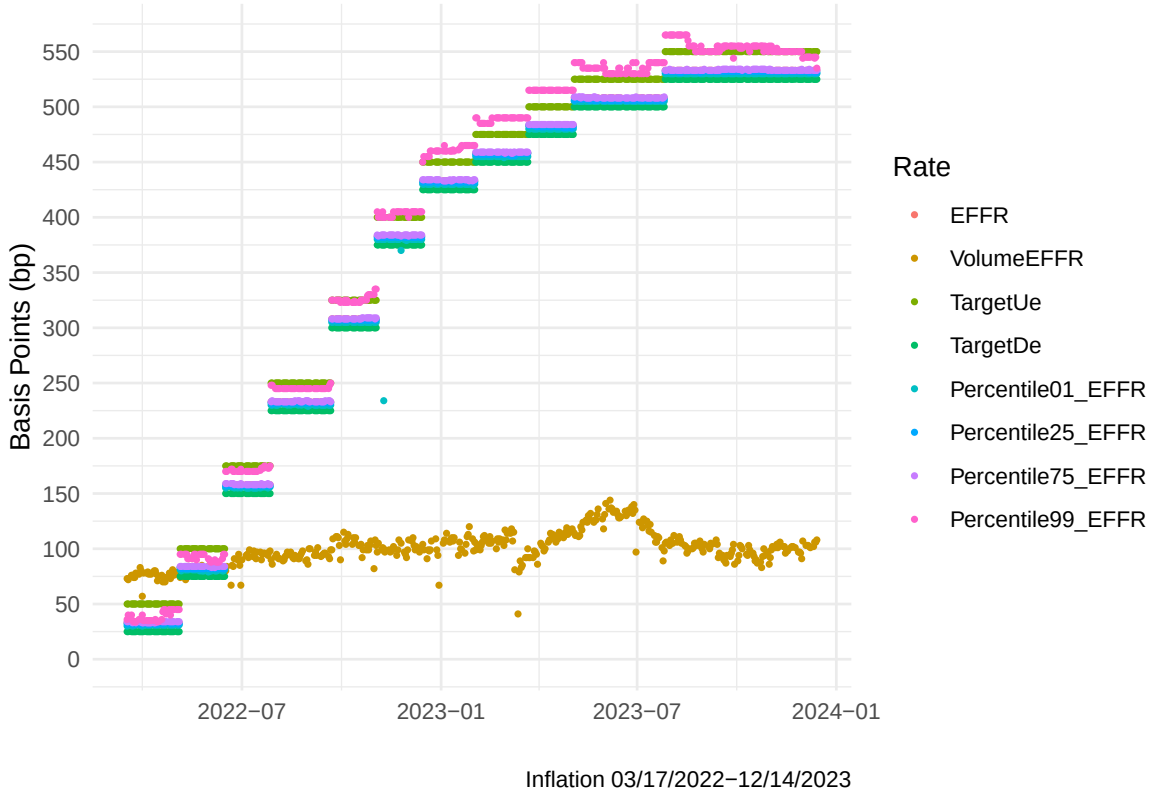
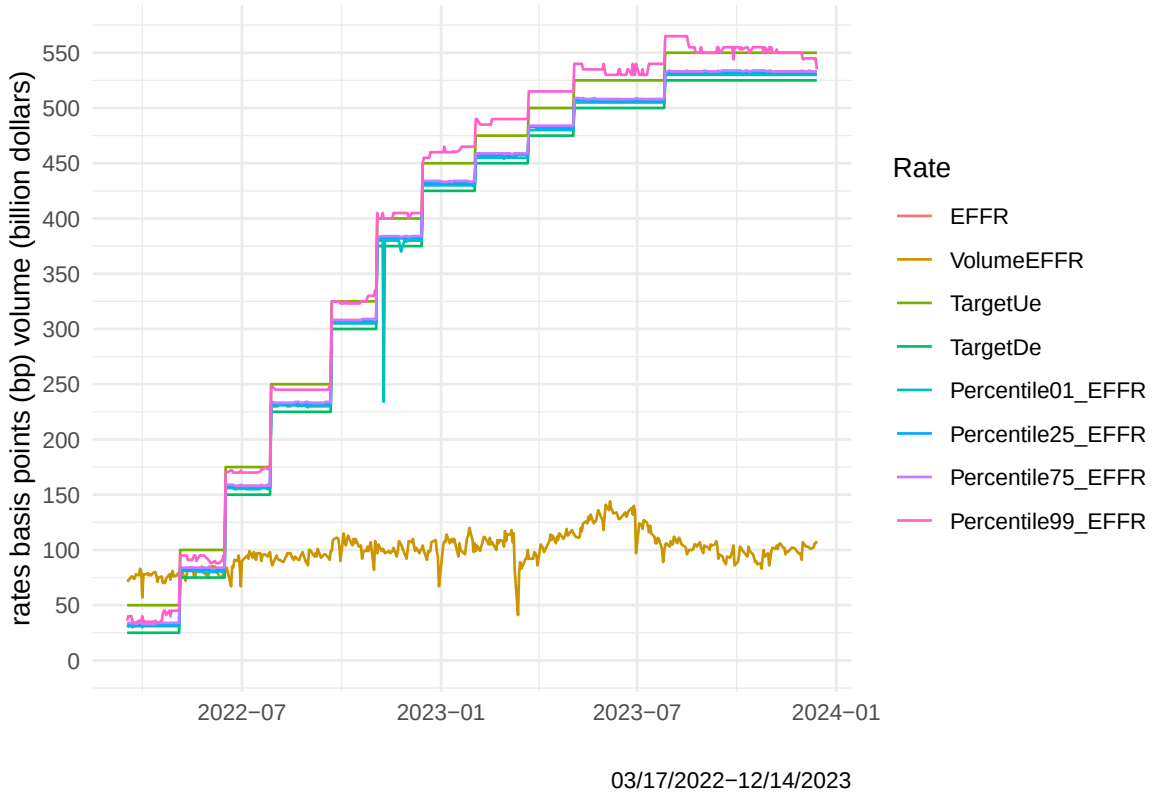


Figure 2: EFFR during Taming inflation 03/17/2022-12/14/2023

```
## [1] 33
```

(see Figure @ref(fig:EFFR during inflation period 3/17/2022-12/14/2023)



see Figure @ref(fig:EFFR during normalcy period 3/4/2016-7/31/2019-plot)

```
## Warning: Removed 271 rows containing missing values (`geom_point()`).
```

```
## Warning: Removed 3 rows containing missing values (`geom_point()`).
```

———————————- combine quintile plots? (see Figure @ref(fig:Rates during different policy episodes)

–> ## boxplots

(see Figure @ref(fig:EFFR Key percentiles during normalcy period 3/4/2016-7/31/2019)

sdate position

(see Figure @ref(fig:EFFR Key percentiles during mid cycle adustment period 8/1/2019-10/31/2019)

(see Figure @ref(fig:EFFR Key percentiles during covid period 11/1/2019-3/16/2020)

```
## [1] 1014
```

```
## [1] 1518
```

(see Figure @ref(fig:EFFR Key percentiles during zero lower bond period 3/17/2020-3/16/2022)

```
## [1] 1519
```

```
## [1] 1957
```

(see Figure @ref(fig:EFFR Key percentiles during inflation period 3/17/2022-12/14/2023) div style="text-align: center;">

see Figure @ref(fig:Boxplots all episodes) "'{r, fig.cap= "Boxplots all episodes 3/4/2016-12/14/2023"} pboxplots<-grid.arrange(bnormalcy, badjust, bcovid, bzlb, binflation, ncol=1) print(pboxplots)

```
<!--
(see Figure \@ref(fig:Key percentiles of overnight rates)
\```{r, fig.cap= "Key percentiles of overnight rates"}
library(cowplot)
```

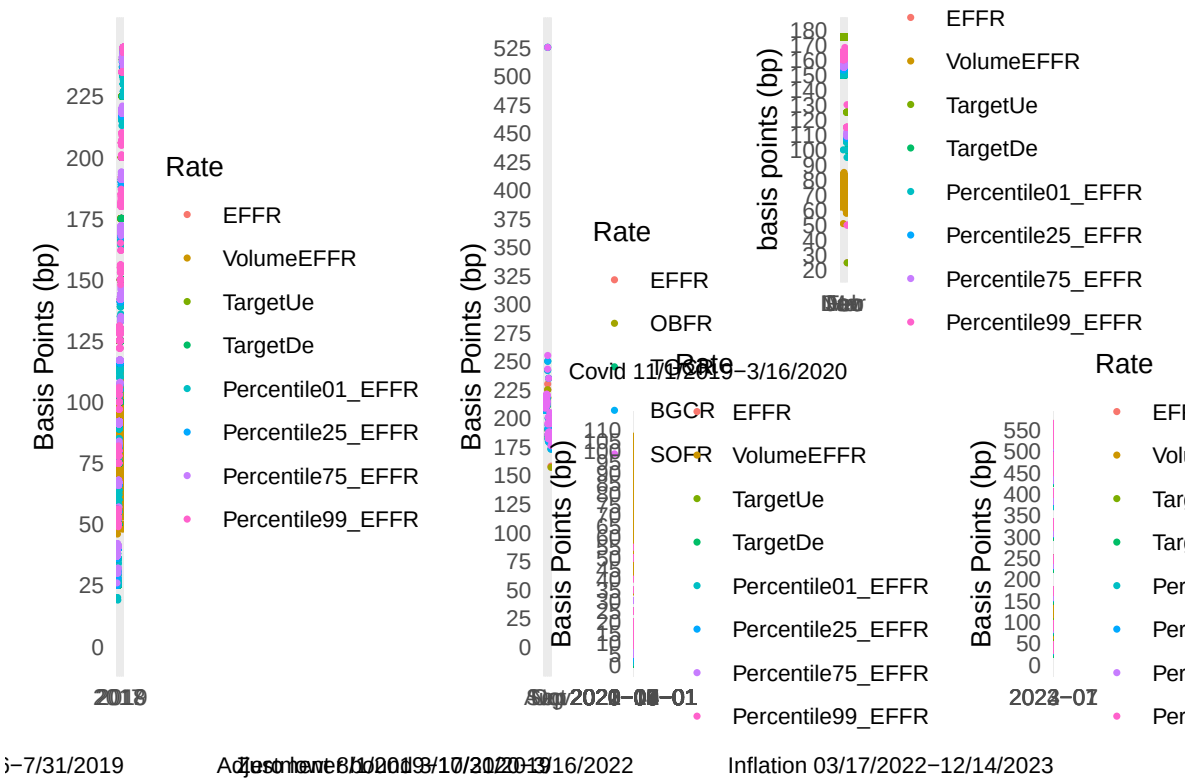


Figure 3: Episodes daily rates 3/4/2016-12/14/2023

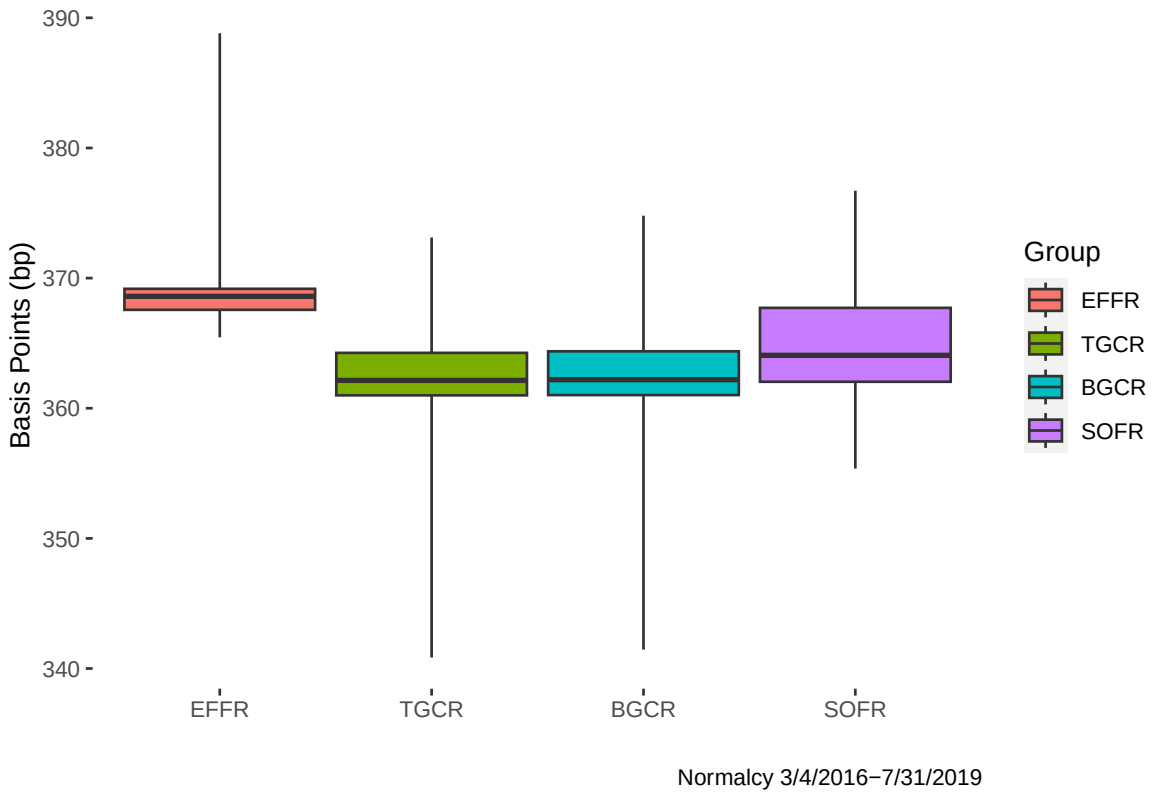


Figure 4: EFFR Key percentiles during normalcy period 3/4/2016-7/31/2019

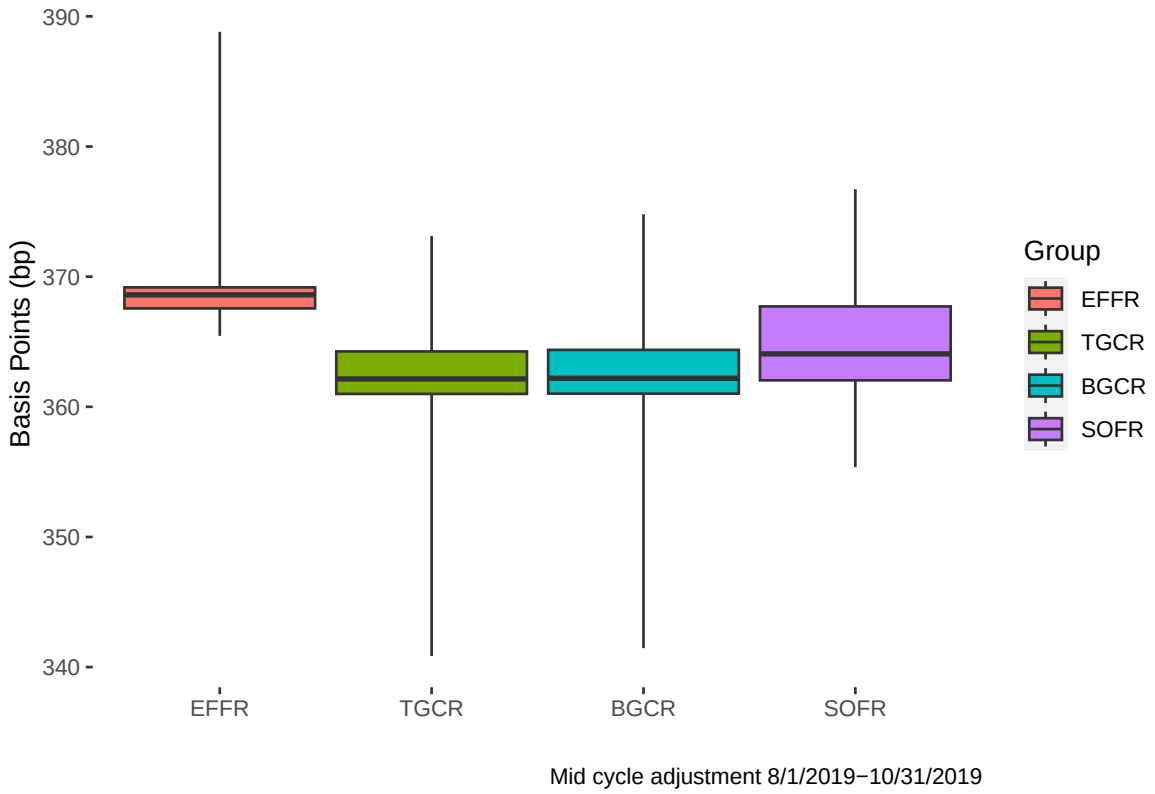


Figure 5: EFFR Key percentiles during mid cycle adustment period 8/1/2019-10/31/2019

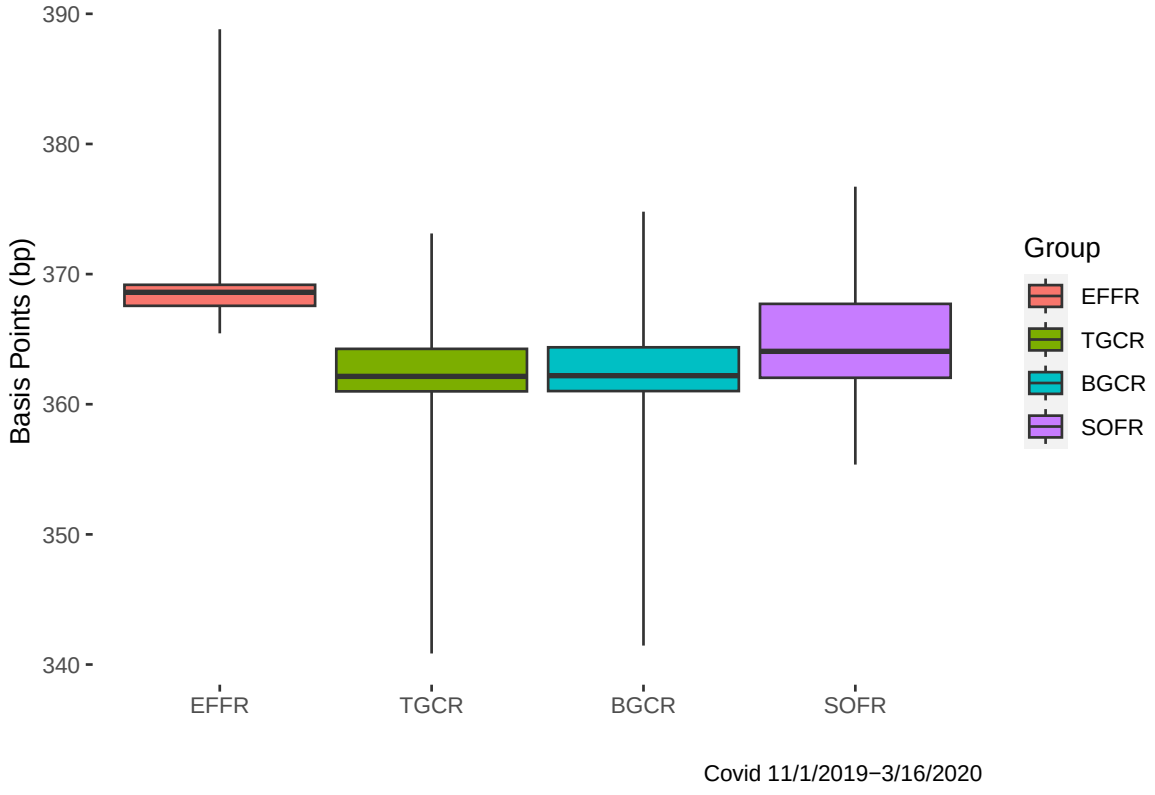


Figure 6: EFFR Key percentiles during covid period 11/1/2019-3/16/2020

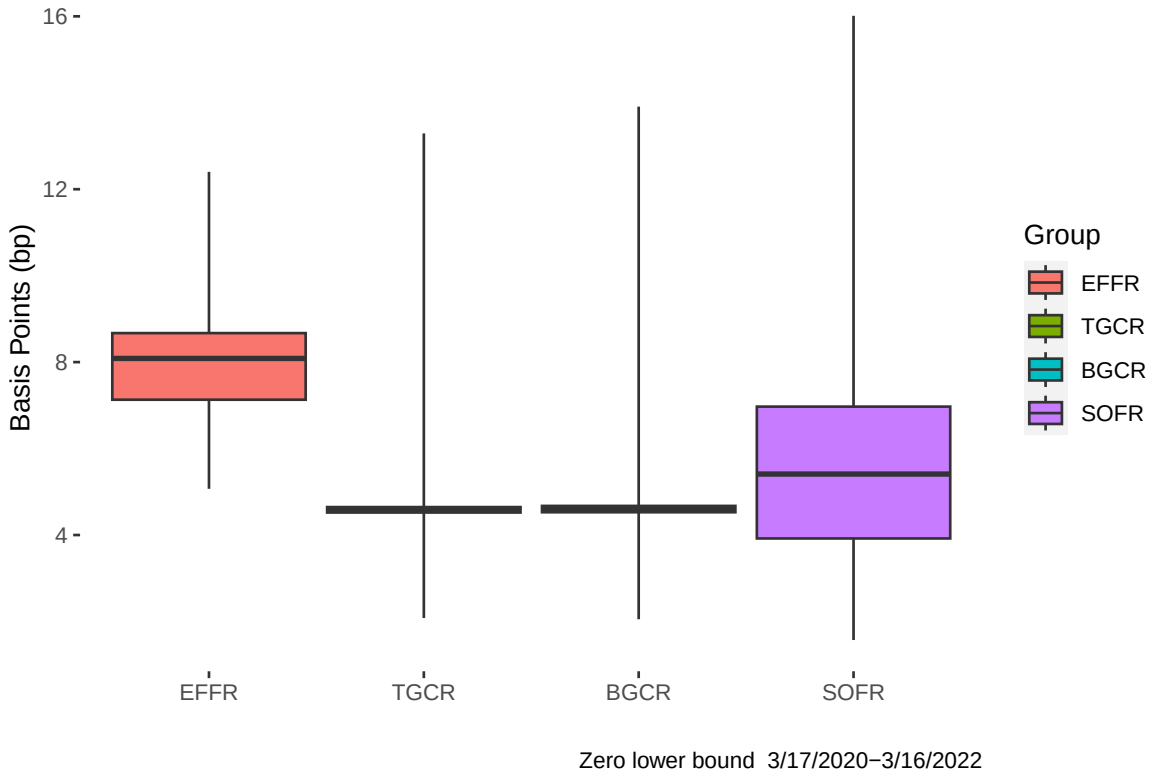


Figure 7: EFFR Key percentiles during zero lower bond period 3/17/2020-3/16/2022

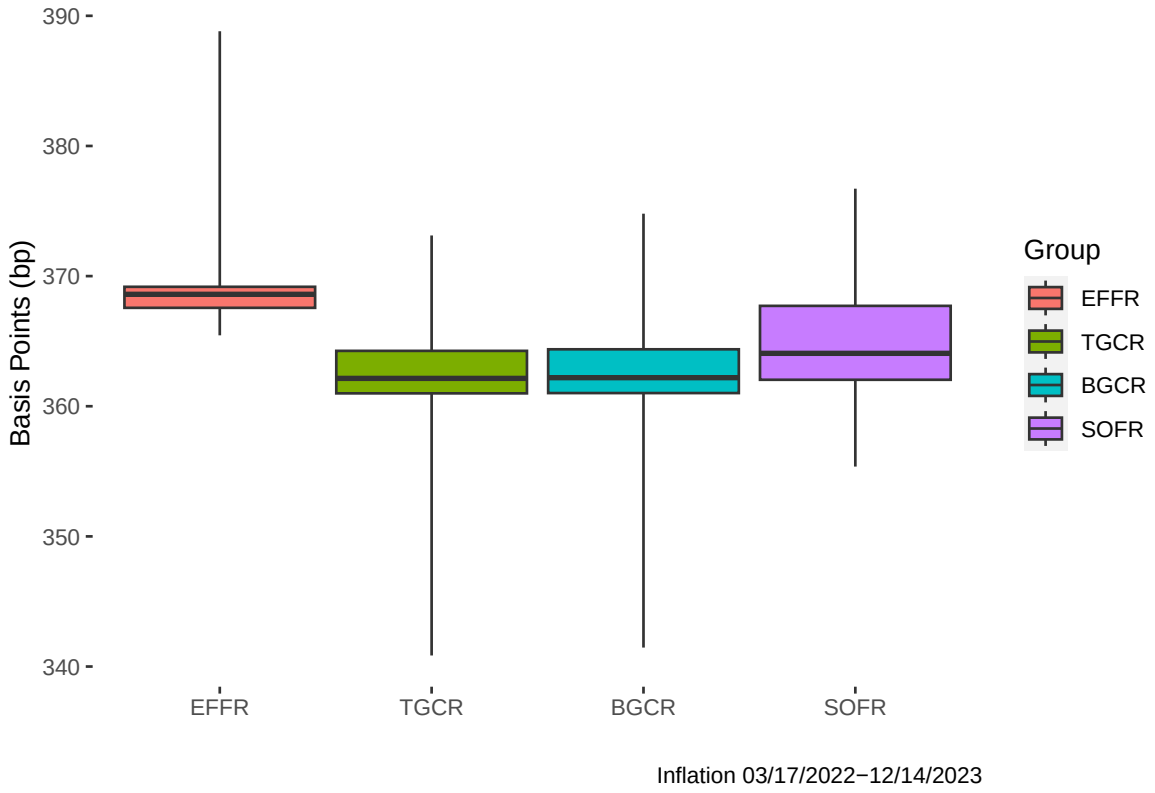


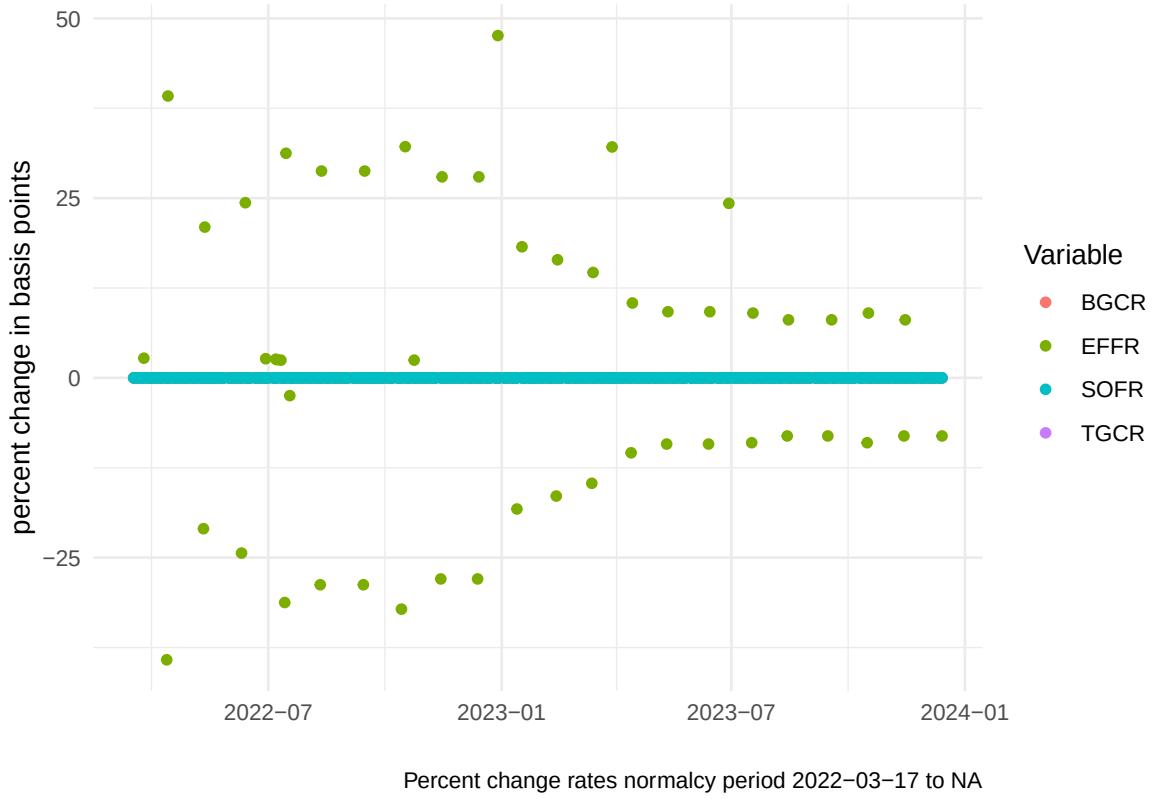
Figure 8: EFFR Key percentiles during inflation period 03/17/2022-12/14/2023

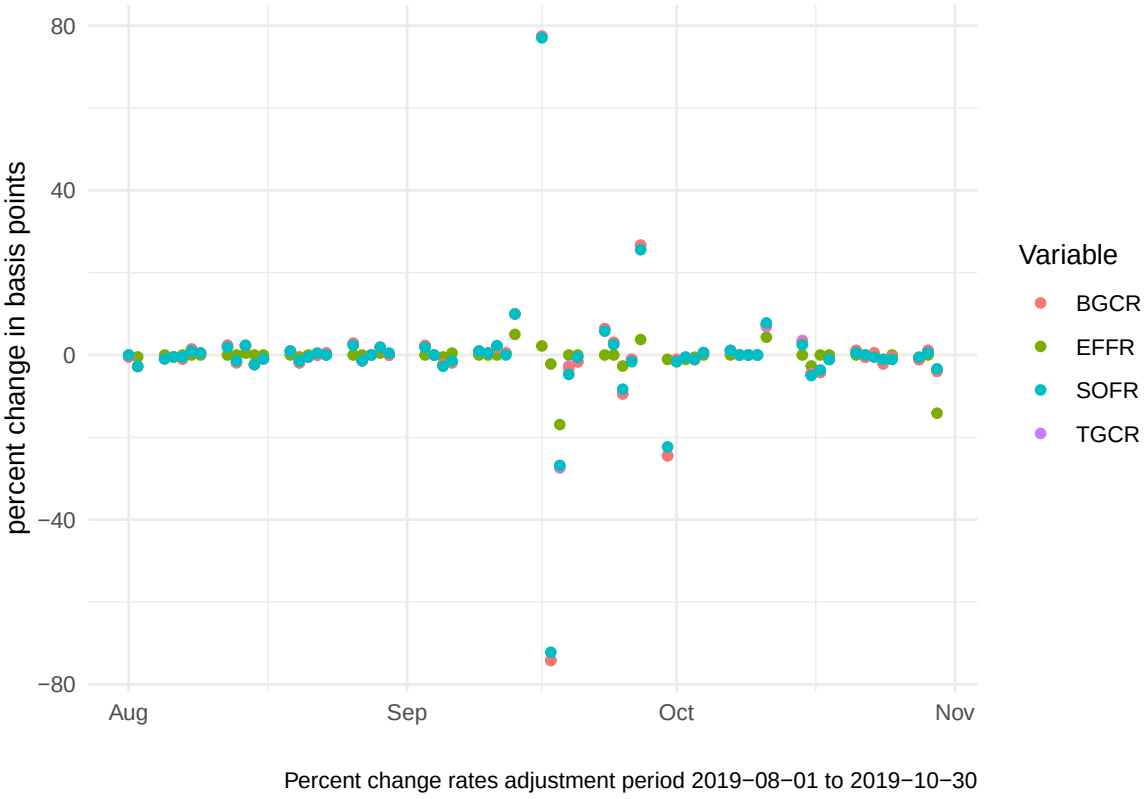
```
#Arrange plots in a 2x3 grid (2 rows, 3 columns)
plot_grid(
  bnormalcy, badjust, bcovid,
  bzlb, binflation,
  labels = c("A", "B", "C", "D", "E"),  # Optional labels for plots
  ncol = 3  # Number of columns in the grid
)
```

->

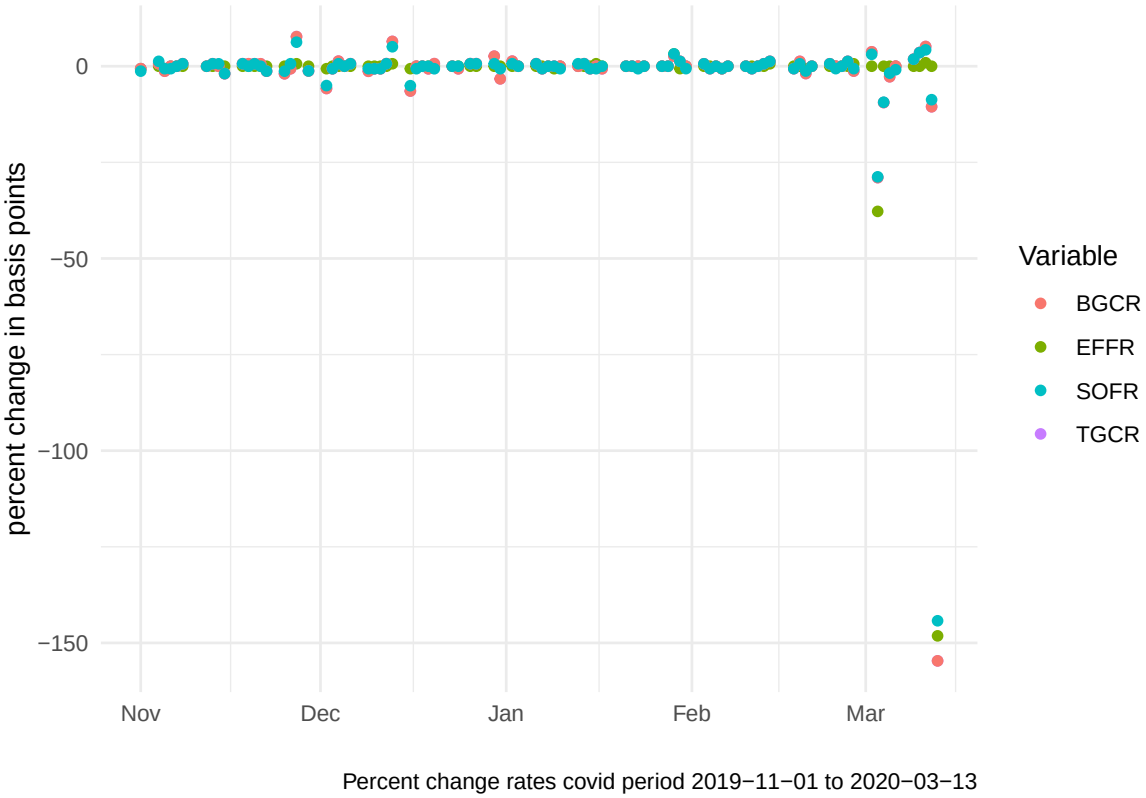
0.2.1 Volatile rates during episodes

```
## Warning: Removed 1672 rows containing missing values (`geom_point()`).
```

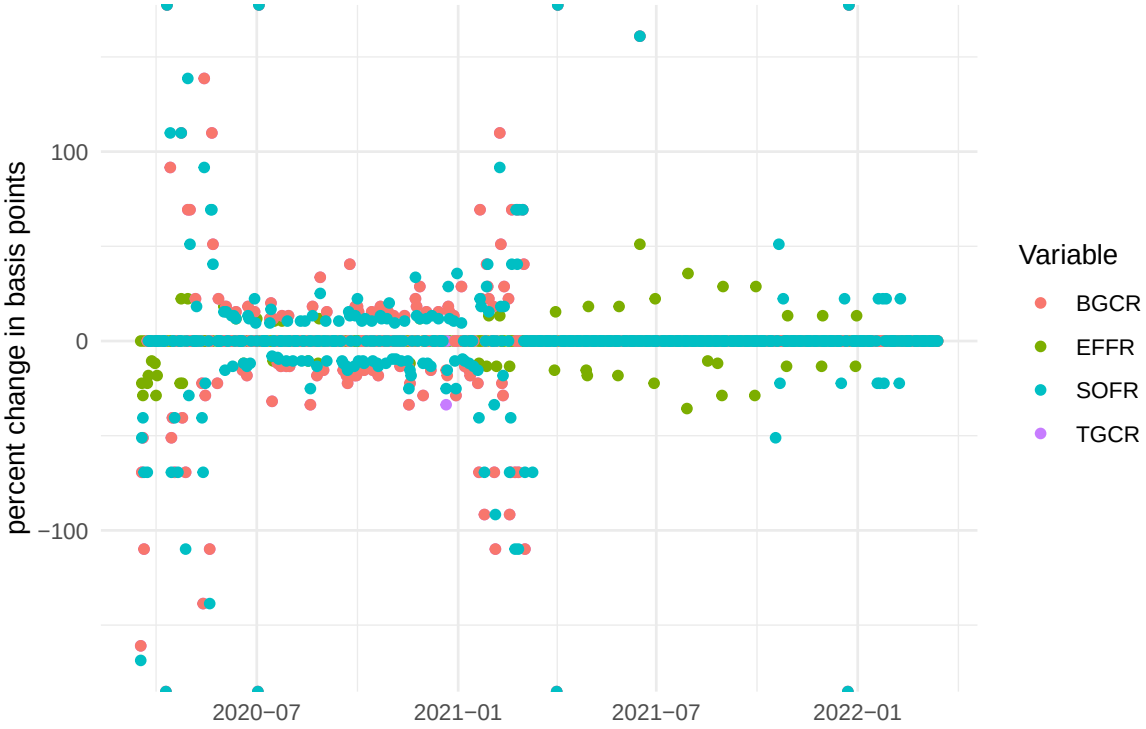




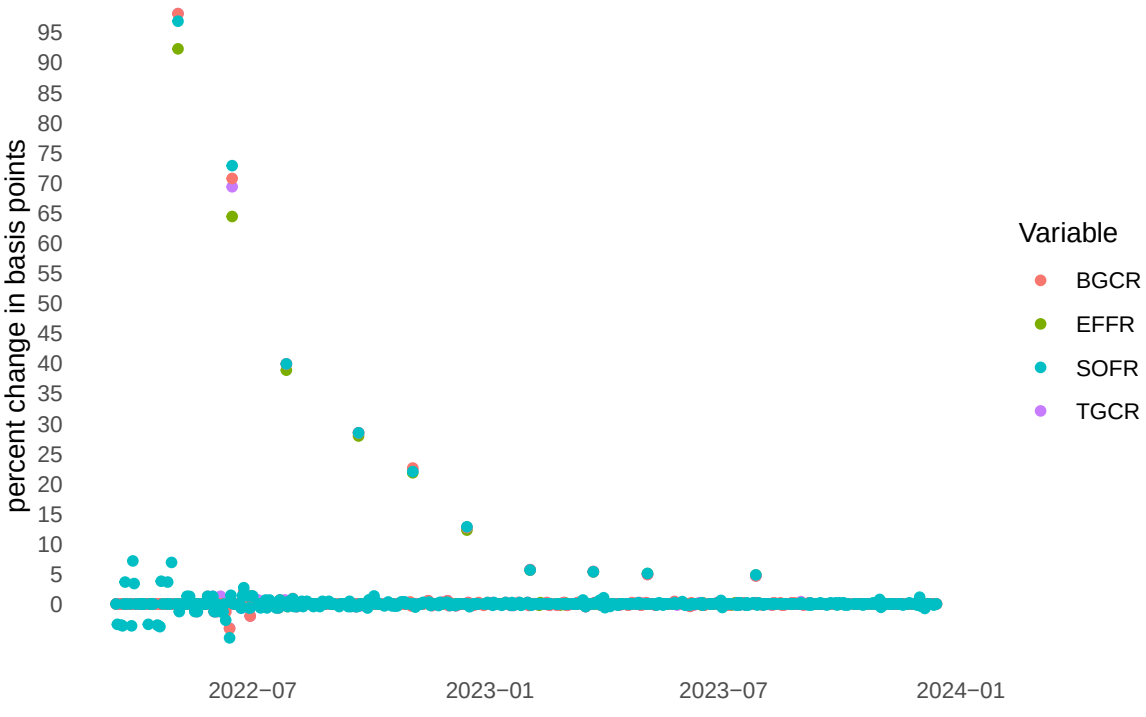
Percent change rates adjustment period 2019−08−01 to 2019−10−30



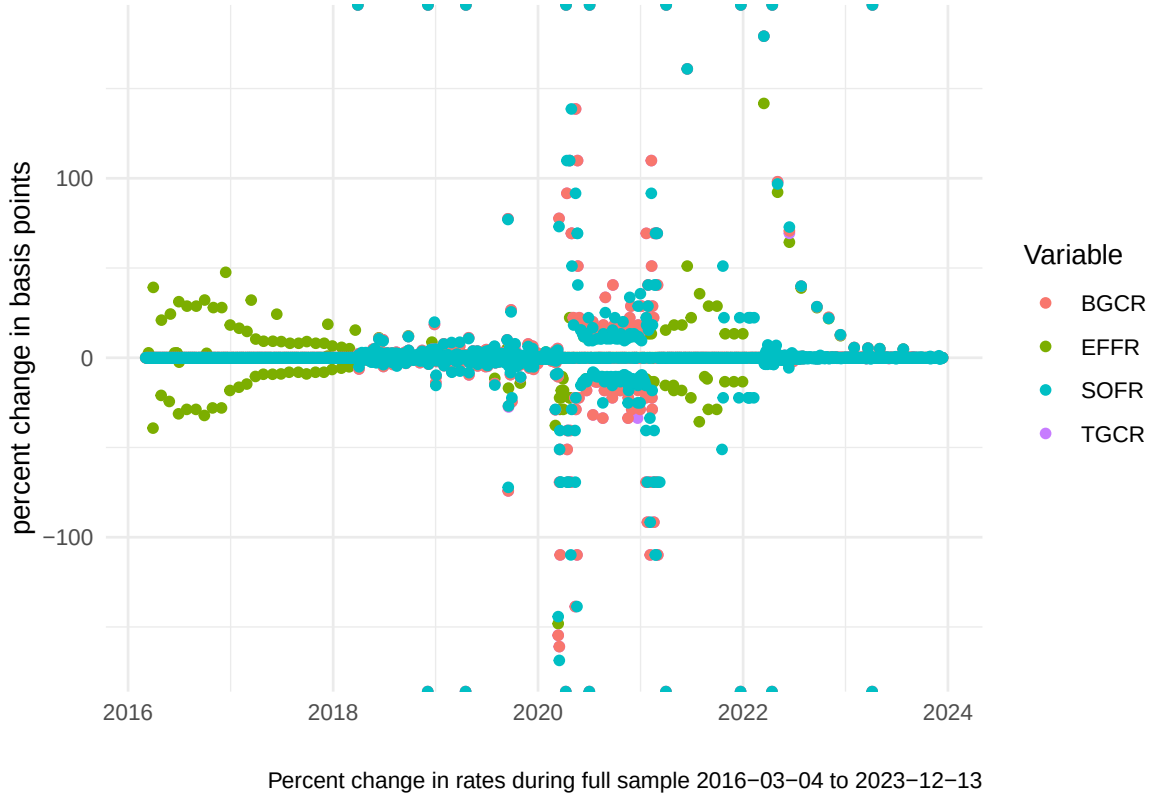
Percent change rates covid period 2019−11−01 to 2020−03−13



Percent change rates zero lower bound period 2020−03−17 to 2022−03−15

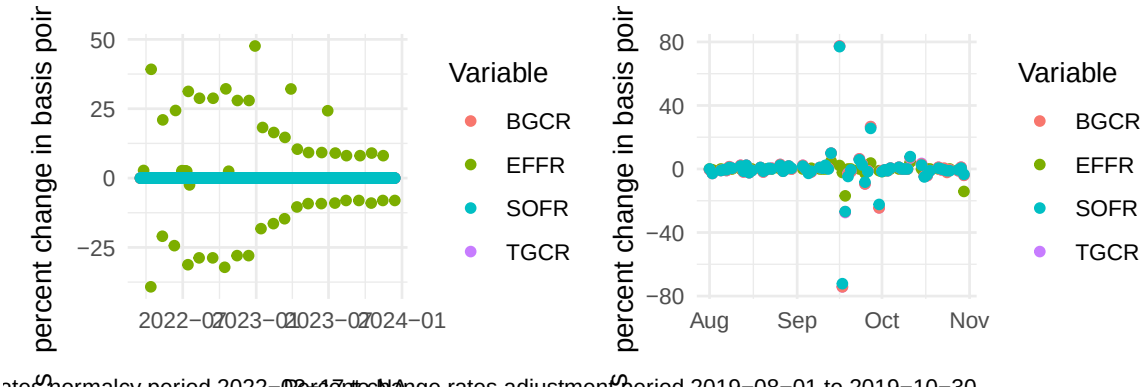


Percent change rates during inflation period 2022−03−17 to 2023−12−13

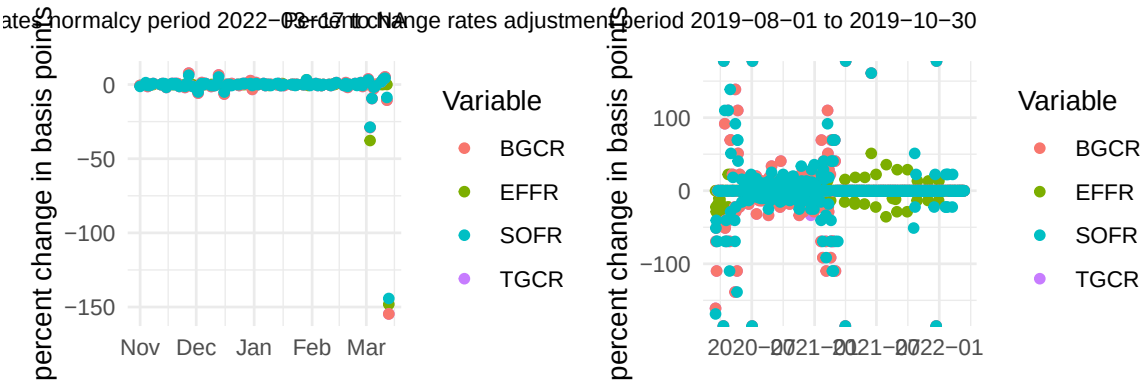


(see Figure @ref(fig:Percent change in rates)

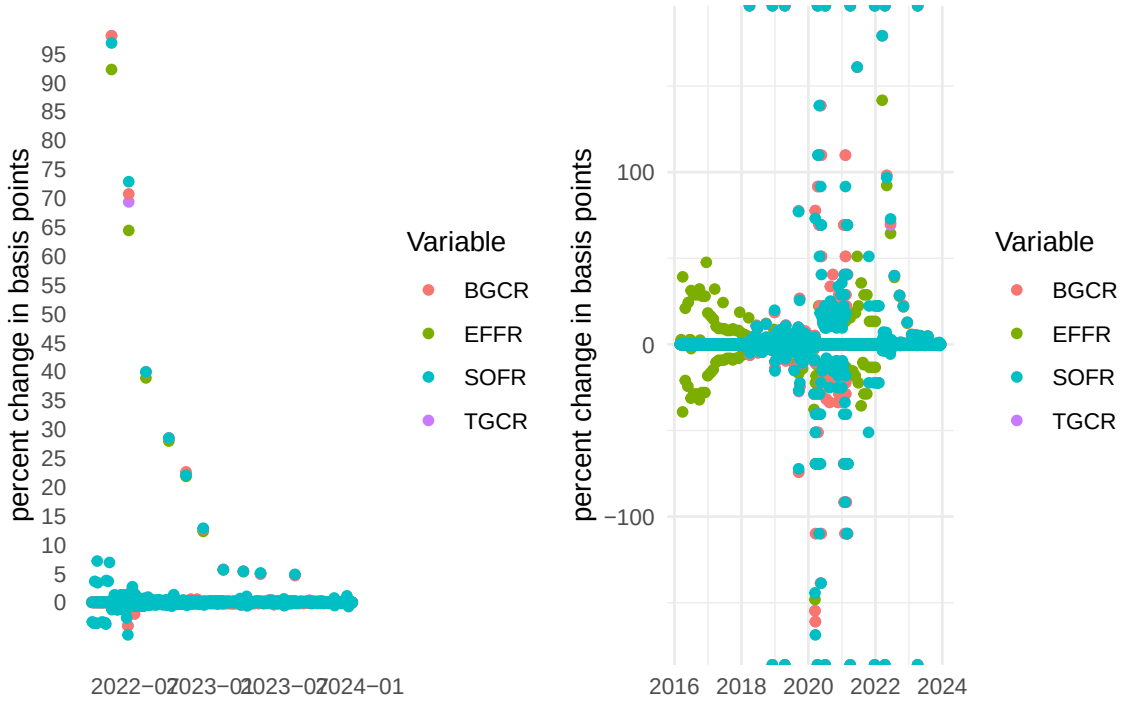
```
## Warning: Removed 1672 rows containing missing values (`geom_point()`).
```



ates normalcy period 2022−03−17 to NA Percent change in rates adjustment period 2019−08−01 to 2019−10−30



ovid period 2019−11−01 to 2020−03−13 Percent change in rates zero lower bound period 2020−03−17 to 2022−03−15



on period 2022−03−17 to 2023−12−13 Change in rates during full sample 2016−03−04 to 2023−12−13

\end{document}