

This is the **README** File to the **Replication Package** for "Testing for parameter change epochs in GARCH time Series " by Stefan Richter, Wang, Weining, and WeiBiao Wu (2022).

Overview

The codes in this replication package constructs the analysis file from the **3** data sources (CMC, 2019; FRED, 2019; YF, 2019) using R. **6 main R files** together with 3 other R help functions/files generate **9** figures and **3** tables in the paper. The replicator should expect to run all the **6** codes for about **20** mins. **3** provided datasets are stored under the folder **Data**, and the output **9** figures are stored under the folder **Figures**.

Data Availability and Provenance Statements

Statement about Rights

- I certify that the author(s) of the manuscript have legitimate access to and permission to use the data used in this manuscript.

Summary of Availability

The data that support the findings of this study are openly available in

- 1) **CoinMarketCap** for Bitcoin series at [Bitcoin price today, BTC to USD live, marketcap and chart | CoinMarketCap](#), reference number [1]. No registration, membership are needed and no cost.
- 2) Federal Reserve Economic Data (FRED) for TED Spread Series at <https://fred.stlouisfed.org/series/TEDRATE>, reference number [2]. No registration, membership are needed and no cost.
- 3) Yahoo Finance for VIX series at <https://uk.finance.yahoo.com/quote/%5EVIX/history?p=%5EVIX>, reference number [3]. No registration, membership are needed and no cost.

Details on each Data Source

Data.Name	Data.Files	Location	Provided	Citation
"TED Spread"	ted_spread.txt	Data/	TRUE	FRED (2019)
"VIX"	Vix.txt	Data/	TRUE	YF(2019)
"Bitcoin"	Bitcoin.txt	Data/	TRUE	CMC(2019)

where the Data.Name column stands for the name of the variables analysed in the paper, and Citation and links to download the data are resolved in the References section of this README.

Computational requirements

Software Requirements

- R&R Studio 4.2.0
 - `library("aTSA")`

- `library("fBasics")`
- `library("truncnorm")`
- `library("rugarch")`
- `library("zoo")`
- `library("lmtest")`
- `library("forecast")`
- `library("xts")`
- `library("tseries")`
- `library("fGarch")`
- `library("TTR")`
- `library("Rcpp")`
- `library("xtable")`
- In each of the main R file, there is a line that could help you install all the packages mentioned above.

Memory and Runtime Requirements

Summary

Approximate time needed to run **all six main R files** on a standard (CURRENT YEAR) desktop machine:

- 10-60 minutes

Details

The code was last run on a **4-core Intel-based laptop with Windows version 10 Pro**.

Description of programs/code

6 Main R files

- Programs in `garch_ted_spread` will produce **Figures 4-5** and results for **Table 1** in the paper. Figure output files are called appropriate names under the folder `Figures` and should be easy to correlate with the manuscript, while Table results could be found in the command area. Moreover, it will also save the estimation results in a R document called `indexed.Rdata` for running `movingwindowfit_ted` (see below).

Approximate running time: 8s

- Programs in `garch_vix` will produce **Figures 7-8** and results for **Table 2** in the paper. Figure output files are called appropriate names under the folder `Figures` and should be easy to correlate with the manuscript, while Table results could be found in the command area. Moreover, it will also save the estimation results in a R document called `index.vix.Rdata` for running `movingwindowfit_vix` (see below).

Approximate running time: 1min 25s

- Programs in `garch_bitcoin` will produce **Figures 10-11** and results for **Table 3** in the paper. Figure output files are called appropriate names under the folder `Figures` and should be easy to correlate with the manuscript, while Table results could be found in the command area. Moreover, it will also save the estimation results in a R document called `index.Rdata` for running `movingwindowfit_bit` (see below).

Approximate running time: 3min 30s

- Programs in `movingwindowfit_ted` will produce **Figures 6** in the paper. Figure output files are called appropriate names under the folder `Figures` and should be easy to correlate with the manuscript.

Approximate running time: 5min 10s

- Programs in `movingwindowfit_vix` will produce **Figures 9** in the paper. Figure output files are called appropriate names under the folder `Figures` and should be easy to correlate with the manuscript.

Approximate running time:

- Programs in `movingwindowfit_bit` will produce **Figure 1** in the paper. Figure output files are called appropriate names under the folder `Figures` and should be easy to correlate with the manuscript.

Approximate running time: 6min 12s

3 Helpful Functions

- Programs in `helpfun.r`, `garchlikelihood.cpp` and `garchlikelihoodgradient.cpp` are **not** main R files and contain helpful functions when running the six main programs.

Instructions to Replicators

- Open each of the six main R files in R Studio , and change/add the path where you store this **replication package** as indicated at the beginning of each R file.
- Install all the necessary packages before loading them.

- Then you should be able to run the code successfully and obtain the desired results. Explanations and comments are also provided within each of the 6 main R file.

List of tables and programs

The provided code reproduces 3 tables and 9 figures in the paper as follows:

Figure/Table #	Program	Figure Outputs (Figures/)	Table Outputs(Table/)
Table 1	garch_ted_spread		table1.tex
Table 2	garch_vix		table2.tex
Table 3	garch_bitcoin		table3.tex
Figures 1	movingwindowfit_bit	paravarying_bit.pdf	
Figures 4-5	garch_ted_spread	ted.pdf (Fig.4) & qqted.pdf(Fig.5)	
Figures 6	movingwindowfit_ted	paravarying_ted.pdf	
Figures 7-8	garch_vix	vix.pdf (Fig.7) & qqvix.pdf (Fig.8)	
Figures 9	movingwindowfit_vix	paravarying_vix.pdf	
Figures 10-11	garch_bitcoin	bit.pdf (Fig.10) & qqbit.pdf (Fig.11)	

References

[1] CoinMarketCap (CMC), 2019. 'Cryptocurrencies-Coins-Bitcoin'. [Bitcoin price today, BTC to USD live, marketcap and chart | CoinMarketCap](#) . (last accessed: 30 Dec 2022).

[2] Federal Reserve Economic Data (FRED), 2019. 'TED Spread Series(TED)', <https://fred.stlouisfed.org/series/TEDRATE>. (last accessed: 30 Dec 2022).

[3] Yahoo Finance (YF), 2019. 'CBOE Volatility Index (VIX) '. <https://uk.finance.yahoo.com/quote/%5EVIX/history?p=%5EVIX>. (last accessed: 30 Dec 2022).