**README: Replication of *Time-Varying Parameters as Ridge Regressions***

## **Overview**

This repository, named **"rc\_final"** contains the necessary data and code to replicate all the figures and tables from the paper **"Time-Varying Parameters as Ridge Regressions"** by Philippe Goulet Coulombe. This README will guide you through the replication process for each figure. This README provides step-by-step instructions to guide you through the replication process for each figure and table. The scripts are written in **R** and **MATLAB**:

* Files with the .R extension are R scripts.
* Files with the .m extension are MATLAB scripts.

By following these instructions, you will be able to reproduce all the results presented in the paper.

**Repository Structure**

The repository is organized into two subfolders (Empirical and Simulation), each corresponding to a figure or set of figures. Each folder contains the specific data and code needed to replicate the respective figure(s):

### **Folder Descriptions**

1. **Empirical/**
   * **00\_prog/:**
     + local\_projection\_figure3\_TVPLP.R – Generate results for Figure 3 : (f), (g) and (h)
     + plots\_local\_projections\_TVPLP.R – Process results for Figure 3 : (f), (g) and (h).
     + local\_projection\_figure3\_VAR.m – Generate results for Figure 3 : (a), (b), (c), (d) and (e). This code also output the Figure 5
     + forecasting\_table16to17.R - Generate results for the tables 16 to 17 and Figure 2
     + results\_table16to17.R - Process results for the tables 16 to 17 and Figure 2.
     + forecasting\_table18.R - Generate results for the table 18
     + results\_table18.R - Process results for the table 18
     + forecasting\_bayes\_figure2.R – Generate results for the “Bayes” models in Figure 2
     + results\_figure2.R – Process results for the Figure 2
   * **10\_data/:** contains the data that are used in the exercise
   * **20\_tools/:** contains the model’s functions and forecasting tools
     + **functions/:**
   * **30\_output/:** contains all the raw outputs
     + **figure3/:**
   * **40\_results/:** contains all the processed outputs
2. **Simulation/**
   * **00\_prog/:**
     + simulation\_table1.R – Simulation producing results for table 1
     + results\_figure1.R - Process results for figure 1
     + simulation\_table2to5.R – Simulation producing results for tables 2 to 5
     + simulation\_table6to9.R – Simulation producing results for tables 6 to 9
     + simulation\_table10to13.R – Simulation producing results for tables 10 to 13
     + results\_table2to13.R – Process results for tables 2 to 13 and output LaTeX tables.
     + simulation\_table14.R – Simulation producing results for the table 14
     + simulation\_table15.Randsimulation\_table15\_only2srr.R– Simulation producing results for table 15
     + results\_table15.R – Process results for table 15
     + results\_figure1.R – Process results from tables 2 to 5 and generate figure 1.
   * **10\_tools/ :** contains the necessary tools functions and models to replicate the results.
     + **functions/ :** contains the model’s functions
     + **simul\_types/:** contains the data generating process function
   * **20\_output/:** contains all the raw outputs
     + **Table1/:**
     + **Table2to13/:**
     + **Table14/:**
     + **Table15/:**
   * **30\_results/:** contains all the processed outputs

## **Data Sources**

The empirical exercise relies on data from both the United States and Canada.

**United States**

We utilize the FRED-QD database, a comprehensive quarterly macroeconomic dataset designed for big data analysis in empirical research. For more details, see:

* **McCracken, M.W., Ng, S. (2020):** *FRED-QD: A Quarterly Database for Macroeconomic Research*, Federal Reserve Bank of St. Louis Working Paper No. 2020005. [DOI: 10.20955/wp.2020.005](https://doi.org/10.20955/wp.2020.005)

**Canada**

The Canadian data is sourced from **Statistics Canada**.

**Dataset Descriptions**

|  |  |  |
| --- | --- | --- |
| **File name** | **Data Source** | **Description** |
| FRED\_QD\_stationnary.csv | [FRED](https://research.stlouisfed.org/econ/mccracken/fred-databases/) | Used for Tables 16–18. Contains stationarized data from FRED-QD. The data as been transform as in McCracken, M.W., Ng, S. (2020) |
| newQ\_targets.csv | [FRED](https://research.stlouisfed.org/econ/mccracken/fred-databases/) | Used for Tables 16–18.  Contains five target variables used in the US forecasting exercise. |
| cs18\_fig4\_ppuzzle.csv | [Statistic Canada](https://www.statcan.gc.ca/en/start) | Used for Figure 3.  Contains eight target variables used in the Canadian exercise. Monthly data as in Champagne and Sekkel (2018) |

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## **Instructions for Replication**

The replication codes for this paper are organized into two main sections: Empirical and Simulation. Below are the specific instructions for replicating each figure and table. Note that the required packages are automatically installed within the provided scripts.

**Empirical**

This section replicates the empirical results, including Figures 2, 3, and 5, as well as Tables 16 to 18.

1. **Tables 16 to 18:**
   1. Run the script forecasting\_table16to17.R to replicate the results of the U.S. forecasting exercise for Tables 16 and 17. This script leverages parallel computing, allowing you to utilize multiple CPU cores to speed up the process. **Set the number of CPU cores**: Specify the number of cores to use for parallel computing (change value of the object “ncores”). If set to 1, the script will run sequentially without parallel processing. **Adjust the working directory**: Modify the relative path variable (wd) to point to your working directory. The script generates results for all combinations of targets, forecasting horizons, and models, covering a total of 60 combinations.
   2. Output: 30\_output/table16to18/TVP\_\*\*\*.RData where \*\*\* is the target’s position, horizon and model.
   3. Run the script results\_table16to17.R to replicate the table 16 and 17. You must modify the relative path variable (wd) to your working directory.
   4. Output: 40\_results/table16.tex, 40\_results/table17.tex
   5. To replicate the Table 18, run the script forecasting\_table18.R. This exercise also run using parallel computing. The same steps apply to this table.
   6. Output: 30\_output/table16to18/TVP\_\*\*\*\_block.RData where \*\*\* is the target’s position, horizon and model.
   7. Run the script results\_table18.R to replicate the table 18. You must modify the relative path variable (wd) to your working directory.
   8. Output: 40\_results/table18.tex
   9. The script results\_figure2.R regenerate the Figure 2. You must modify the relative path variable (wd) to your working directory. It will output the barplots for all variables and horizons.
2. **Figure 2:**
   1. The script forecasting\_bayes\_figure2.R the Bayes models in the Figure 2. As for tables 16-18, the script leverages parallel computing, allowing you to utilize multiple CPU cores to speed up the process. **Set the number of CPU cores**: Specify the number of cores to use for parallel computing (change value of the object “ncores”). If set to 1, the script will run sequentially without parallel processing. **Adjust the working directory**: Modify the relative path variable (wd) to point to your working directory. The script generates results for all combinations of targets, forecasting horizons, and models, covering a total of 30 combinations (AR and ARDI).
   2. The script results\_figure2.R regenerate the Figure 2. You must modify the relative path variable (wd) to your working directory. It will output the barplots for all variables and horizons.
3. **Figures 3 and 5:**
   1. Run the MATLAB script local\_projection\_figure3\_VAR.m to replicate the VAR results. Modify the relative path variable (wd) to your working directory. This script generates Figures 3(a)–(e) and Figure 5. The results are stored in the 40\_results/ folder.
   2. Output: 40\_results/figure3\_inflation\_VAR.png, figure3\_GDP\_VAR4.png, figure3\_inflation\_VAR8.png, figure3\_GDP\_VAR8.png, figure3\_UR\_VAR8.png and figure5.png
   3. Run the script local\_projection\_figure3\_TVPLP.R to replicate the TVP-LP VAR results. Modify the relative path variable (wd) to your working directory. The simulation results will be stored in the 20\_output/table/ folder. This script generates Figures 3(f)–(h)
   4. Output: 40\_results/figure3\_TVP-LP\_Inflation.html, figure3\_TVP-LP\_GDP.html and figure3\_TVP-LP\_Unemp.html

**Simulation**

This section replicates simulation exercises, including Tables 1 to 15 and Figures 1 and 4.

1. **Table 1:**
   1. Run the script simulation\_table1.R to generate the simulation results. Modify the relative path variable (wd) to your working directory. The simulation results will be stored in the 20\_output/table1/ folder.
   2. Use the script results\_table1.R to create Table 1. Modify the path variable ("wd") in the code.
   3. Output: 40\_results/table1.csv
2. **Tables 2 to 13:** 
   1. Run the scripts simulation\_table2to5.R, simulation\_table6to9.R and simulation\_table10to13.R to replicate the simulation results. Modify the relative path variable (wd) to your working directory. The scripts can be run in any order, and results will be saved in respective folders (20\_output/table2to5, 20\_output/table6to9/ or 20\_output/table10to13/., one file per simulation)
   2. Use the script results\_table2to13.R to generate Tables 2 to 13. Modify the relative path variable (wd) to your working directory.
   3. Output: 40\_results/table\_\*.tex. (where "\*" is the table number).
3. **Table 14:**
   1. Run the script simulation\_table14.R to replicate the simulation results. Modify the relative path variable (wd) to your working directory. The simulation results will be stored in the 20\_output/table14/ folder.
   2. The table will output in the console
   3. Output: 30\_results/table14.csv
4. **Table 15:**
   1. Run the scripts simulation\_table15.R and simulation\_table15\_only2srr.R to replicate the simulation results. Modify the relative path variable (wd) to your working directory. The simulations results will be stored in the 20\_output/table15/ folder.
   2. Run the script results\_tables15.R to generate the table. Only modify the relative path variable ("wd") in the code. The table output in the console and in the folder 30\_results/ (one file per simulation)
   3. Output: 30\_results/table15.csv
5. **Figure 1**
   1. Run the script results\_figure1.R to replicate the figure. Modify the relative path variable (wd) to your working directory. The results come from simulation\_table2to5.R.
   2. Output: 30\_results/figure1a.png and 30\_results/figure1b.png
6. **Figure 4**
   1. Run the script results\_figure4.R to replicate the figure. Modify the relative path variable (wd) to your working directory.
   2. Output: 30\_results/figure4.png

**Software Requirements**

To replicate the figures, the following software and packages are required:

* **R** version 4.1.2
* **MATLAB 2023a**

*The results have been produced on a MacBook Air M1.*

**R Packages:**

* bvarsv
* pracma
* matrixcalc
* MASS
* glmnet
* fGarch
* shrinkTVP
* Hmisc
* Readr
* GA
* e1071
* glmnet
* timeSeries
* doParallel
* foreach
* extrafont
* ggplot2
* htmlwidgets
* RColorBrewer
* reshape2
* grid
* ggthemes

**Troubleshooting**

If you encounter any issues, please ensure the following:

* All necessary R packages are installed.
* The data files are correctly placed in the specified folders.
* The relative path variable “path” or “wd” is correct.