REPLICATION FILES: When is Growth at Risk?[1]

July 2, 2020

This document describes the replication code and data for the paper Plagborg-Møller, Reichlin, Ricco, and Hasenzagl (2020) and its supplementary appendix. The code was written and run in Matlab R2019b and Stata SE 15.

1 Out-of-sample estimation

The code that reproduces the results in Sections I, II, and V can be found in the folder "outofsample". The folder also contains functions and code snippets from replication files of Adrian et al. (2019) and Bańbura and Modugno (2010).

Code structure. The code is organized as follows:

- *QR_library:* Contains functions used to perform the quantile regressions for the forecasting and nowcasting exercises in section II.

- *DFM_library:* Contains functions used to estimate the dynamic factor models.

- *Descriptive_charts:* Contains scripts that generate the descriptive charts from section I.

- *Models:* Contains scripts that perform the forecasting and nowcasting exercises in sections II and V and generate the charts. Each subdirectory contains a "MAIN.m" script that runs the exercise and saves the results and a "charts.m" script that loads the results from the exercise and plots the figures. The subdirectories are:

  - *forecast:* Runs the forecasting exercise from section II.A and produces the figures
  - *real_time:* Runs the real-time nowcasting exercise from section II.B and produces the figures
  - *covid:* Runs the covid case study from section V and produces the figures
  - *pseudo_real_time:* Runs the nowcasting exercise with pseudo real-time data. (Only figure 5 is included in the paper)

Figures. The following programs reproduce the figures:

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Figure	Directory	Script
Figure 1,2,3,&4	Descriptive_charts	descriptive_MAIN.m
Figure 5	models/pseudo_real_time	charts.m
Figure 6	models/forecast	charts.m
Figure 7	models/forecast	charts.m
Figure 8	models/real_time	charts.m
Figure 9	models/real_time	charts.m
Figure 14	models/covid	charts.m
Figure S.1	Descriptive_charts	Made in Excel file *loadings.xsls*
Figure S.2	models/forecast	charts.m

2 In-sample estimation

The code that reproduces the results in Sections III and IV can be found in the folder "insample".

Required software. To run the Bayesian estimation, the Matlab package MatlabStan[2] is required, which in turn relies on the freeware software package CmdStan.[3] Please follow the installation instructions. The code has been tested with MatlabStan version 2.15 and CmdStan version 2.21. Once MatlabStan has been installed, copy the file "insample/matlabstan/rdump.m" to the "+mstan" sub-folder of the MatlabStan installation directory, replacing the existing file of that name.

The replication files already contain the output of all the relevant Stan estimation runs (see below for details). Hence, it is only necessary to install MatlabStan and CmdStan if you want to re-run the estimation procedures.

The Stata code requires the packages "kountry" and "tabout", which can be downloaded using the `ssc install` command.

Code structure. The code is organized as follows:

- *data*: Data files and code for creating preliminary data sets used in estimation.

- *estim*: Estimation routines, including Stan model files, figure/table creation. Subdirectories:

  - *auxiliary functions*: Missing data imputation via Dynamic Factor Model, skew-t functions, Bayesian VAR inference.

  - *output*: Output of estimation routines and figure/table creation. Further subdirectories:

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[2]https://github.com/brian-lau/MatlabStan/wiki
[3]https://mc-stan.org/users/interfaces/cmdstan.html

* *fig_tab*: Figures and tables. Subfolders "global" and "us" contain cross-country and U.S. analysis, respectively. Further subfolders "factor" and "var" contain results with factors and individual variables as predictors, respectively. Further subfolders "skewt" and "condhet" contain results for the dynamic skew-t and conditional heteroskedasticity models, respectively.
* *stan*: Bayesian estimation results produced by Stan. The subfolder structure is the same as in the "fig_tab" directory.

Replication instructions. To replicate all figures and tables, follow these steps.

1. Execute "run_1.do" in Stata. This creates preliminary data sets, international crisis statistics, and runs benchmark linear regressions. See file for specifics. The output of the crisis summary statistics can be found in the file "data/global/output/crises.log", while the output of the benchmark regression analysis can be found in the folder "estim/output/fig_tab".

2. Execute "run_2.m" in Matlab, once for each setting of the variable `run_spec` set at the top of the file (6 different settings total). This runs the various Bayesian estimation routines, which should replicate the results reported in the paper up to random noise.[4] Note that each of these runs can take hours. This entire step can be skipped if you do not want to replicate the posterior sampling results.

3. Execute "run_3.m" in Matlab, once for each setting of the variable `run_spec` set at the top of the file (8 different settings total). This produces most of the figures and tables reported in the paper, as indicated in the code. The figures and tables can be found in the relevant subdirectories of the "estim/output/fig_tab" folder.

4. Execute "run_4.do" in Stata. This creates the remaining figures and tables, as indicated in the code.

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[4]In rare cases, the posterior sampling routine does not converge with the given random seed because the algorithm gets stuck in the warm-up phase. In these cases, we re-ran the analysis with different random seeds and subsequently checked convergence diagnostics. As mentioned previously, all the stored posterior sampling results used in the paper are provided with these replication files.

References

Tobias Adrian, Nina Boyarchenko, and Domenico Giannone. Vulnerable Growth. *American Economic Review*, 109(4):1263–1289, April 2019. doi: 10.1257/aer.20161923. URL http://www.aeaweb.org/articles?id=10.1257/aer.20161923.

Marta Bańbura and Michele Modugno. Maximum likelihood estimation of factor models on data sets with arbitrary pattern of missing data. Working Paper Series 1189, European Central Bank, May 2010. URL https://ideas.repec.org/p/ecb/ecbwps/20101189.html.

Mikkel Plagborg-Møller, Lucrezia Reichlin, Giovanni Ricco, and Thomas Hasenzagl. When is Growth at Risk? Paper presented at the Brookings Papers on Economic Activity Spring 2020 Meeting, 2020.