Replication files for "Identifying Shocks via Time-Varying Volatility"

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This readme describes Matlab files provided to replicate the the results found in the main text of "Identifying Shocks via Time-Varying Volatility" as well as the additional empirical results found in Section 1 of the online supplement. There are three sections: dependencies on existing packages written by others, to which I offer links; the master programs that run the empirical analysis; and a description of all the supporting programs called by these main programs. The results in the paper were obtained in Matlab 2019b on a 2017 13-inch MacBook Pro, 2.5GHz i7, running Mojave 10.14.6. The replication code for the simulation studies in the online supplement (underlying Sections 2, 3, 4, and 6) is available upon request.

Data Availability Statement   I certify that I have legitimate access to and permission to use the data used in this paper. This paper uses the January 2018 vintage of the McCracken & Ng FRED-MD database, McCracken and Ng. The data is provided for public use. This archive contains a reformatted version of the data in the folder "`Supporting programs and data/MCNG.csv`". This paper uses data obtained from Mertens and Ravn (2014a), the replication package for Mertens and Ravn (2014b). The authors allow redistribution of the data, provided an appropriate citation is provided. This archive contains the data in the folder "`Supporting programs and data/JME2014_data.xls`". The data citations below and in the main text have the full URLs to the source data.

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1   External Dependencies

I make use of replication files and several packages written by others. These files should all be downloaded and included in the subfolder "`Auxiliary Files`".

1. `subplot1.m`: this function provides greater control over subplot behaviour. It is not included in the replication file, but is freely available for download from Mathworks File Exchange, Ofek (2006).

2. `tightfig.m`: this function is used to reduce white space in figures. It is not included in the replication file, but is freely available for download from Mathworks File Exchange, Crozier (2018).

3. `nearestSPD.m`: this function computes the nearest symmetric positive definite matrix to an input matrix `A`. It is not included in the replication file, but is freely available for download from Mathworks File Exchange, D'Errico (2013).

4. `sparseinv`: this function computes a subset of `inv(A)` for a real sparse matrix `A` using Takahashi's equations. It is used in the E-step of EM algorithm to estimate the AR(1) SV model. It must be "installed" using the included file prior to use. It is not included in the replication file, but is freely available for download from Mathworks File Exchange, Davis (2014).

5. MS_Regress package: this package estimates a Markov switching model via maximum likelihood. It is used to implement TVV-ID based on a Markov switching estimator in the empirical application, called by `Empirical_analysis.m`. The entire package (including many sub-functions used by the function I call directly, `MS_Regress_Fit.m`) must be accessible by Matlab. It is not included in the replication file, but is freely available for download from Marcelo Perlin's github page, Perlin (2017).

6. Replication package for Mertens and Ravn (2014a): this replication package provides the data for the empirical application and estimates the

benchmark models, as well as some additional comparisons in the supplement, throughout `Empirical_analysis.m`. It is not included in the replication file, but is freely available for download from Mertens's webpage, https://karelmertens.com/research/, see Mertens and Ravn (2014b). The raw data file, `JME2014_data.xls`, is included here.

7. Replication package for Caldara and Kamps (2017): this replication package estimates the model for comparison in Figure 11 in the supplement. The file `Replicate_Figure_3_to_7_Table_2_and_3.m` is called by my program, `Empirical_analysis.m`, to generate the required esimates (saved as `Results_Figure3.mat`). Note that to produce the 95% credible set seen in my results, the file `Replicate_Figure_3_to_7_Table_2_and_3.m` must be modified at line 51, setting `ptileVEC = [0.025 0.50 0.975];`. It is not included in the replication file, but is freely available for download from Caldara's webpage, https://sites.google.com/view/dariocaldara/publications

8. Replication package for Leeper, Richter, and Walker (2012): this replication package provides measures of fiscal foresight used to reconstruct the alternative foresight-adjusted narrative measures in Mertens and Ravn (2014a). In particular, `Empirical_analysis.m` uses fields of the object `ITR_AFTR.mat`, which is saved when running the program `AFTR.m`. It is not included in the replication file, but is freely available for download from the AEA webpage, https://www.aeaweb.org/articles?id=10.1257/pol.4.2.115.

9. FRED-MD database: this database, described by McCracken and Ng, provides the underlying data for Figure 1. I use a December 2017 vintage, with the columns reordered to facilitate the analysis. I include this `.csv` file in the folder "`Supporting programs and data`", and it is called by `Figure_1.m`; the original source is https://research.stlouisfed.org/econ/mccracken/fred-databases/.

2   Master programs

1. `Figure_1.m`: this program loads the FRED-MD database transforms and cleans the data, estimates an AR(12) model for each series, estimates an autoregressive model for the squared residuals, computes tests of homoskedasticity, and produces Figure 1 in the main text.

2. `Empirical_analysis.m`: this program performs all empirical analysis in the paper and online supplement. In particular, it produces Figures 2-7 and Tables 1-3 in the main text, as well as Figures 8-13 and Tables 4-10 in the online supplement.

3   Supporting programs and data

These supporting programs and data are called by the two master files and are contained in the folder "`Supporting programs and data`".

1. `MCNG.csv` is a reformatting of the January 2018 vintage of the FRED-MD database, McCracken and Ng, and called by `Figure_1.m`.

2. `JME2014_data.xls` is the raw data from Mertens and Ravn (2014a), obtained from the replication package, Mertens and Ravn (2014b), and should be cited accordingly.

3. `CD_ID.m` runs the Cragg-Donald test of the TVV-ID identification conditions and is called by `Empirical_analysis.m` to verify identification.

4. `Gaussianelimination.m` is called by `CD_ID.m` and performs Gaussian elimination as an intermediate step to compute the Cragg-Donald test statistic.

5. `Cyclestartvalues.m` runs the AR(1) SV EM algorithm for a grid of start values, then uses the results to initialize a final run, as described in the online supplement. It is called by `Empirical_analysis.m` to estimate an AR(1) SV model, identifying the model via time-varying volatility.

6. `SV_EM_cov.m` estimates the AR(1) SV model using the EM algorithm. It is called by `Cyclestartvalues.m`. It draws heavily on replication code for Bertsche and Braun (2020) (obtained from the authors) and Chan and Grant (2016) (http://joshuachan.org/research.html).

7. `E_step_cov.m` performs the E-step of the EM algorithm in `SV_EM_cov.m`.

8. `min_logpost_H.m` computes the log-likelihood of the structural shocks in the M-step of the EM algorithm in `SV_EM_cov.m`.

9. `llh_full_raw.m` computes the full log-likelihood of the AR(1) SV model prior to unit-normalization of H in `SV_EM_cov.m`.

10. `llh_full.m` computes the full log-likelihood of the AR(1) SV model following unit-normalization of H in `SV_EM_cov.m`.

11. `gradnum.m` performs numerical differentiation and is used to compute the score of the log-likelihood of the AR(1) SV model in `SV_EM_cov.m`.

12. `Hnormn.m` is used to determine the column ordering of H closest to a reference matrix under the L^2 norm in `SV_EM_cov.m` as well as for alternative estimators in `Empirical_analysis.m`.

13. `bootstrap_reducedform.m` is called by `Empirical_analysis.m` and runs a wild bootstrap for the reduced-form VARs based on that of Mertens and Ravn (2014).

14. `MS_Regress_Fit.m`, from the MS_Regress package, estimates the Markov switching model. It is called by `Empirical_analysis.m`.

15. `GARCHLLH3.m` computes the log-likelihood of a 3-dimensional GARCH model and is used to estimate that model in `Empirical_analysis.m`.

16. `SV_EM_orth.m` estimates the AR(1) SV model for a vector of (already) orthogonal shocks and is called by `Empirical_analysis.m`.

4   Output files

The table below details the output files corresponding to figures and tables in the main text and additional empirical results in the online supplement, all of which can be found in the "results" folder.

Figure/Table	Program	Output file
Figure 1	Figure_1.m	Figure_1.eps
Figure 2	Empirical_analysis.m	Figure_2.eps
Figure 3	Empirical_analysis.m	Figure_3.eps
Figure 4	Empirical_analysis.m	Figure_4.eps
Figure 5	Empirical_analysis.m	Figure_5.eps
Figure 6	Empirical_analysis.m	Figure_6.eps
Figure 7	Empirical_analysis.m	Figure_7.eps
Table 1	Empirical_analysis.m	Table_1.mat
Table 2	Empirical_analysis.m	Table_2_tax.mat, Table_2_spending.mat
Table 3	Empirical_analysis.m	Table_3.mat
Figure 8	Empirical_analysis.m	Figure_8.eps
Figure 9	Empirical_analysis.m	Figure_9.eps
Figure 10	Empirical_analysis.m	Figure_10.eps
Figure 11	Empirical_analysis.m	Figure_11.eps
Figure 12	Empirical_analysis.m	Figure_12.eps
Figure 13	Empirical_analysis.m	Figure_13.eps
Table 4	Empirical_analysis.m	Table_4.mat
Table 7	Empirical_analysis.m	Table_7.mat
Table 8	Empirical_analysis.m	Table_8.mat
Table 9	Empirical_analysis.m	Table_9.mat
Table 10	Empirical_analysis.m	Table_10_tax.mat, Table_10_spending.mat

Additional output files from Empirical_analysis.m include:

1. estimates_full.mat: estimates for baseline model based on TVV-ID.

2. estimates_00.mat: estimates for subsample ending in 2000 based on TVV-ID.

3. estimates_70_00.mat: estimates for subsample starting in 1970 and ending in 2000 based on TVV-ID.

4. estimates_70.mat: estimates for subsample starting in 1970 based on TVV-ID.

5. estimates_80_00.mat: estimates for subsample starting in 1980 and ending in 2000 based on TVV-ID.

6. `estimates_80.mat`: estimates for subsample starting in 1980 based on TVV-ID.

7. `Table_3_pvals.mat`: Table of p-values for entries in Table 3.

8. `ITR_AFTR.mat`: results from Leeper, Richter, and Walker (2012), generated by `AFTR.m` in that paper's replication code, used to anticipation-adjust tax shocks.

9. `Results_Figure3.mat`: results from Caldara and Kamps (2017), generated by `Replicate_Figure_3_to_7_Table_2_and_3.m` in that paper's replication code, for use in Figure 11.

10. `Empirics.mat`: full set of empirical results (and intermediate objects) generated after running `Empirical_analysis.m`.

References

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