

# Implementation into Dynare

All results are calculated with the DYNARE package. Since we deviate from standard estimation and solution techniques, we have changed the original DYNARE code with respect to our needs. The supplementary code provided together with this appendix works together with the DYNARE package 4.0.3.. Given the continuously ongoing development of DYNARE, we cannot ensure that all our adjustments run with all DYNARE distributions. For this reason, we provide in this Section an overview over the main changes we made. This should help to implement our approach also in current versions of Dynare or in other packages.

To implement the the pure estimation approach it is just necessary to modify two files in Dynare:

1. `dynare_resolve.m`: This file is adjusted to solve for the stochastic steady state. This subroutine is always called when a recalculation of the model solution is necessary. As described in the paper, we have to solve a fixed point problem. Therefore we use initial values for the conditional second moments to calculate the model solution linearized around a deterministic steady state. Afterwards, we run a loop where we update the conditional second moments based on the model solution linearized around the stochastic steady state based on the “new” conditional second moments. The loops when a minimization criterion is fulfilled.
2. `DsgeLikelihood.m`: At the end of the file, we additionally subtract the log-pdf of the constrained prior  $h$  from the unconstrained log-posterior. (Because this function returns the negative of the log posterior we subtract instead of adding the term.) This file also includes some penalty function which checks if some restrictions regarding the implicitly calculated parameters are fulfilled (e.g.  $\nu > 0$   $\eta > \nu/(\nu + 1)$  and  $\alpha > -1$ ).

While the former changes are a minimum to ensure the estimation, it is not enough to ensure that other routines are handling the stochastic steady state or the constrained prior correctly, e.g. for the command `stoch_simul` the corresponding file `stoch_simul.m` has to be adjusted accordingly to `dynare_resolve.m`. Moreover, we have changed some more files to make the estimation more convenient. We shortly report which files we have adjusted and for which reason (you find these files also in the supplementary code):

1. `dynare_estimation_1.m`: This file sets up the estimation by Dynare. We have added some command lines to produce a similar output on the screen and to save our additional parameters (conditional moments) or implicitly calculated parameters (e.g.  $\beta$ ) in the corresponding file `*_mode.mat`.
2. `metropolis_hastings_initialization.m` and `random_walk_metropolis_hastings.m`: These files initialize and run the metropolis hastings algorithm. Therefore we have added some command lines to save our additional parameters or implicitly calculated parameters along the chains. This allows to use these chains later on for some analysis, but also make it possible that we can use some older chains to restart the estimation (option: `load_mh_file` or `mh_recover`)

3. `posterior_analysis.m`: We have adjusted the file to ensure that the stochastic steady state and not the deterministic steady state is used for calculating predicted posterior statistics. Some more smaller changes were made to calculate or retrieve some available statistics (e.g. cross-correlations).
4. `GetPosteriorParametersStatistics.m` and `GetAllPosteriorDraws2.m`: The first file is slightly changed to calculate and save posterior statistics for the implicitly calculated and the additional calculated parameters. In this regard the second file is a clone of `GetAllPosteriorDraws.m` with the difference that it loads all draws for the implicitly and the additional calculated parameters.