

Read Me for "Estimating Behavioral New Keynesian Model under Zero Lower Bound"

This readme file provides step-by-step instructions for replicating the estimation results of the models presented in our paper and for creating the figures and tables included in the paper. Our research findings primarily rely on the use of MATLAB software, incorporating the "**parallel computing**" toolbox and additional toolboxes for "**statistics and machine learning**" and "**optimization**."

The program code for replication is organized into FOUR folders as outlined below:

1. The estimation folder is labeled "**Est_Nonlin_BNK_model**."
2. The folder "**Check_Regions_Convergence**" contains the code for calculating regions where the equilibrium solution converges using the estimated parameters.
3. The folder "**Make_Tables_and_Figures**" is configured for creating figures and tables.
4. Additionally, "**toolbox_BNK_US**" comprises common codes used by the aforementioned code sets.

Contents of Codes in "toolbox_BNK_US"

The structure of Matlab codes and adopted methods for solving and estimating, excluding files that set underlying models or load data, are consistent across the four main folders. Six common functions are stored in the four main folders as follows:

1. A sub-folder "**TL_Toolbox**," inherent and selected from the "Toolbox" provided by Rickter, Throckmorton, and Walker (2014), is mainly used for solving a nonlinear model through Time Iteration with Linear Interpolation (TL).
2. A sub-folder "**fun_projection**" is a set of functions for solving our NK model using the aforementioned "TL_Toolbox."
3. Three sub-folders, namely "**fun_smc**," "**fun_particle_filter**," and "**fun_prior**," contain functions used for SMC square methods, particle filter for estimating endogenous variables, and sampling parameters from prior distributions, respectively.
4. In a sub-folder "data" of "**toolbox_BNK_US**," data files and prior setting files are stored, including:
 - "**data_us.csv**" for data, including the first difference of GDP per capita.
 - "**prior_setting_US_BNK.csv**" for setting values of prior distributions and calibrations of parameters.
 - An M-file: "**load_data.m**," in the sub-folder: "fun_smc," loads the above data files, while an M-file: "**fun_prior_setting.m**," in the sub-folder: "fun_prior," loads the prior setting file.

How to Run the Codes in the Estimation Section

The main programs for estimation are "**model_BR.m**" and "**model_RE.m**," corresponding to TWO models in "**Est_Nonlin_BNK_model**." These TWO codes call an M-file, e.g., "**main_habit_smc2.m**," which executes the SMC square procedure after setting the models and estimation options. The key steps include:

1. Setting options for models, ZLB (zlbflag = 0 or 1), monetary policy rule (policy_flag = 1 or 2), and estimation options such as the number of particles for parameters (nsim), SMC stage (nstage), and particles for shocks (nparticles) in Line 25 through 45 of M-file: "model_BR."
2. Specifying the number of cores for parallel computing (ncore) in Line 21.
3. Setting the number of sampled parameters for SMC^2 after the 2nd stage (nsim_out) in Line 35.
4. Defining the number of sampled parameters for the 1st stage (nsim) in Line 35.
5. Specifying the measurement error options, such as m_err_flag, m_error, in Line 41.
6. Matlab Code of Model Definition is in a sub-folder: "fun_projection," including:
 - ① "eqm_BNK_habit.m," describing the equations of a nonlinear NK model.
 - ② 2. M-file of this model definition called from "solve_model_habit.m" in the folder 'fun_smc.'
7. Posterior Estimations of parameters sampled by the SMC method are saved in **Mat-files** with the following format: '/output/save_para_(est_type)_(behave_flag)_(zlbflag)_(policy_flag)_(nsim)_(nparticles).mat'
8. "main_plot_result.m" describes estimation results and draws graphs of macro-variables and impulse responses.

How to Calculate Regions of Convergence of Equilibrium

For the **Main_Batch.m** code in the folder "Check_Regions_Convergence," revise the following line and then execute it.

- **How to Load Estimation Results**

1. To load the estimation results, set "update" on line 60 to "1".
If not, set it to 0 and update the file **P=parameters.m** on line 21. Also, update the values on lines 74-80.
2. To select a type of model, choose a number from line 56 to line 60
(F.behave_flag = 1 for BR, 0 for RE;
F.zlbflag = 1 for On, 0 for off;
F.policy_flag = 1 for Notional Rate Model, 2 for Nominal Rate Model).

- **Set Convergence Accuracy** in Line 83: **P.tol = 1e-5**; (please change).
- **Set the Number of Grids** in Line 104-108: **O.y_pts = 5; O.r_pts = 5; O.MP_pts = 5; O.b_pts = 1; O.a_pts = 1;**

How to Make Tables and Figures

Reproduce the Tables and Figures of the body and Appendix of our paper by executing the code files named with the corresponding number of Table or Figure in the folder "Make_Tables_and_Figures."