Monetary Policy and Inequality under Labor Market Frictions and Capital-Skill Complementarity

Readme for the replication codes of the theoretical model

Juan J. Dolado, Gergő Motyovszki and Evi Pappa

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1 Computational requirements

1.1 Software requirements

- Matlab (Release 2018b)
  - Optimization toolbox
  - Symbolic toolbox
  - Portions of the code were originally written and run in Matlab 2015b. These portions are also compatible with Matlab 2018b, but then they result in slightly different font sizes and zooming properties for some of the figures compared to the 2015b versions used in the manuscript. (However, more recent portions of the code are sometimes not backward compatible with 2015b and they do require 2018b).
- IRIS Toolbox (release 2015-01-27)
  - This is an open-source toolbox similar to Dynare, for macroeconomic modelling, forecasting and time series analysis. In particular, for solving DSGE models with perturbation methods (Schmitt-Grohé and Uribe, 2004). It runs on Matlab.
  - The latest version of the toolbox and detailed documentation can be downloaded from `https://iris.igpmn.org/` or `https://github.com/IRIS-Solutions-Team/IRIS-Toolbox`
  - In this code we have used an older version of the toolbox, released on 27 January 2015. This might no longer be available for download, and in order to avoid any potential

incompatibility of our code with future releases of the toolbox, we have included the IRIS Toolbox release 20150127 in this repository. Documentation corresponding to this version (IRIS Solutions Team, 2015) can be obtained by typing `irisman` into the Matlab command window after an IRIS session has been started up (see later), which should bring up the file `help/IRIS_Man.pdf` from the toolbox folder.

- LaTeXcompiling engine: MiKTeX 2.8
  - IRIS Toolbox can detect and use LaTeX installations on the computer, which is useful for figure generation when figure titles and legends include Greek letters and mathematical objects. This is not a crucial requirement, but without this generated figures might display the actual code instead of proper symbols.

1.2 Memory and runtime requirements

The code was run on a Dell computer with the following specifications:

- operation system: Windows 8.1 pro (64-bit)
- processor: Intel 4-Core i7-4510U CPU @ 2.00GHz
- RAM: 8.00 GB

All computations and figure generation are finished within 30 minutes.

1.3 Description of programs

- the folder `IRIS_Tbx_20150127` contains the particular release of the IRIS toolbox used for these codes
- main functions
  - `DMP_monpol_CSC_main.m`: This is the main file which starts up an IRIS session, sets parameters for different calibration scenarios, solves the corresponding DSGE model for each of them, and simulate impulse response functions for various shocks, as well as implements the decomposition of the log-linearized wage bargaining equation. It calls `DMP_monpol_CSC_steady.m` and `DMP_monpol_CSC.model`, and finally it saves results in output files `DMP_results.mat` and `DMP_irf_results.mat`.
  - `DMP_monpol_CSC_steady.m`: This function calculates the steady state of the model according to our calculation and calibration strategy detailed in Section D.2. of our Online Appendix. As input, it uses exogenous parameters and steady-state targets (set in `DMP_monpol_CSC_main.m`). As output, it gives a structure variable, which includes all the parameters and solved steady state values for all model variables.

- DMP_monpol_CSC.model: This is a file written in IRIS-specific model file language. It defines all the variables, parameters and dynamic equilibrium conditions of our DSGE model, as described in Section D.1. of our Online Appendix. It is called by DMP_monpol_CSC_main.m to create an IRIS model object when solving the model.
- DMP_figures.m: This file generates output displaying all the numerical results and figures used in the theoretical part of our paper. It uses saved results from DMP_results.mat and DMP_irf_results.mat (which in turn were generated by DMP_monpol_CSC_main.m), and then saves the resulting output into subfolders charts and numbers.
- calibration_table.tex: This LaTeX file replicates Table 1 in our manuscript containing parameters and steady state values. It uses input stored in the numbers subfolder (which were saved there by DMP_figures.m)

- auxiliary functions
  - hline.m draws formatted horizontal lines on plots
  - vline.m draws formatted vertical lines on plots
  - figureFullScreen.m is used in the code DMP_figures.m, and sets the given figure object to be displayed at full screen mode, so that it is more readily examinable and is printed/saved in a larger size. It worked well on our Windows 8.1 computer, but it might generate error messages on certain Mac OS versions. The corresponding lines in DMP_figures.m can be commented out without any serious drawback, however, the printed/saved figures might be of different size from the ones used by us.
- results
  - DMP_results.mat and DMP_irf_results.mat contain all the numerical results of our theoretical analysis with our DSGE model (solved model objects, parameters, impulse responses etc – for various calibrations)
  - charts folder: contains all the figures generated by DMP_figures.m (These are to be subsequently used as inputs to our manuscript and Online Appendix).
  - numbers folder: contains all the baseline parameters and steady state values printed into separate *.tex files by DMP_figures.m (These are to be subsequently used by calibration_table.tex).
  - Note: neither of these result files are necessary to run the codes, as they will be generated by the codes anyway. But having them already in place could allow to skip running certain codes, which can save time.

Note:

- Some variable and parameter names used in the codes do not have a straightforward match with the symbols used in the paper for the same variables/parameters (due to a series of requested changes in notation). However, the description of each variable/parameter and the structure of the model as defined and outlined in `DMP_monpol_CSC.model` should make the correspondance between them clear.

2 Instructions

1. Set current folder in Matlab to where this repository is saved/extracted.
2. Run `DMP_monpol_CSC_main.m`
   - This adds the 2015-01-27 release of the IRIS Toolbox to the current Matlab path. The command "`irisstartup`" starts up an IRIS session. If you have already started up an IRIS session earlier, then this part of the code can be commented out.
   - This file calls `DMP_monpol_CSC_steady.m` and `DMP_monpol_CSC.model`, so make sure they are in the same folder.
   - This file generates `DMP_results.mat` and `DMP_irf_results.mat` which will be needed later.
3. Run `DMP_figures.m`
   - This file uses `DMP_results.mat` and `DMP_irf_results.mat`, so make sure they already exist and are in the same folder.
   - If you have generated the `*_results.mat` files in a previous, *and by now closed*, IRIS session, then you need to start up an IRIS session again, as described in the previous step. Just uncomment the corresponding portion of this code at the very beginning.
   - This file generates output for results in the `charts` and `numbers` subfolders, which are used in our manuscript.
4. Run `calibration_table.tex` with a LaTeX compiler engine
   - This file uses input from the `numbers` subfolder, so make sure it already exists and is in the same folder.

3 List of figures and tables

Table 1 is generated from results saved into separate `*.tex` files in the `numbers` subfolder.

- Lines 36-61 of `DMP_figures.m` do the saving. Filenames are constructed according to the syntax `{coeffname}_{scenario}.tex`, where various values for `{coeffname}` are listed in the "coeffnamelist" cell on line 43, and `{scenario}` is set to "base" in line 50, denoting our baseline calibration.

- calibration_table.tex does the compiling, which results in the final output of our Table 1

Figures

- We use 10 types of figures, annotated by f1, f2, f3, f4, f5, w1, w2, w3, w4, and w5 in the code DMP_figures.m
- These figure types are filled up with content in loops for different combinations of
  - alternative calibration scenarios (*pp* keeps track of these),
  - alternative scenario comparisons (*kk* keeps track of these), and
  - alternative shocks (*jj* keeps track of these)
- This is why multiple figures can be generated by the same lines in the code, just for different combinations of *jj*, *kk* and/or *pp*
- Note: These codes generate more figures than those appearing in our manuscript, since figures appearing in the Online Appendix are also created here.

Table 1: List of theoretical figures appearing in the main text of the manuscript and in its Appendix

Figures	**Program**	**Line no.**	**Output file**	**Note**
Figure 2	DMP_figures.m	236	figure2_v_baseline.eps	
Figure 3	DMP_figures.m	179	figure1_v_base.eps	
Figure 4	DMP_figures.m	277	figure3_v_baseline.eps	
Figure 5	DMP_figures.m	480	w1_base.eps	
Figure 6	DMP_figures.m	638	w5_baseline.eps	for $kk = 1$
Figure 7	DMP_figures.m	638	w5_gamma.eps	for $kk = 4$
Figure 8	DMP_figures.m	332	figure4_v.eps	
Figure 10	DMP_figures.m	239	figure2_g_baseline.eps	for $jj = 3, kk = 1$
Figure 11	DMP_figures.m	280	figure3_g_baseline.eps	for $jj = 3, kk = 1$
Figure 12	DMP_figures.m	239	figure2_qq_baseline.eps	for $jj = 7, kk = 1$
Figure 13	DMP_figures.m	280	figure3_qq_baseline.eps	for $jj = 7, kk = 1$
Figure 14	DMP_figures.m	239	figure2_v_symphi.eps	for $jj = 4, kk = 3$
Figure 15	DMP_figures.m	280	figure3_v_symphi.eps	for $jj = 4, kk = 3$
Figure 16	DMP_figures.m	477	w1_scen77.eps	for $pp = 77$
Figure 17	DMP_figures.m	635	w5_symphi.eps	for $kk = 3$

Table 2: List of theoretical figures appearing in the Online Appendix

Figures	**Program**	**Line no.**	**Output file**	**Note**
O.A. Figure 7	`DMP_figures.m`	396	`figure5_v_sigma.eps`	for $jj = 4, kk = 5$
O.A. Figure 8	`DMP_figures.m`	396	`figure5_v_psi.eps`	for $jj = 4, kk = 6$
O.A. Figure 9	`DMP_figures.m`	396	`figure5_v_xi.eps`	for $jj = 4, kk = 7$
O.A. Figure 10	`DMP_figures.m`	396	`figure5_v_omega.eps`	for $jj = 4, kk = 8$
O.A. Figure 11	`DMP_figures.m`	396	`figure5_v_alpha.eps`	for $jj = 4, kk = 9$
O.A. Figure 12	`DMP_figures.m`	396	`figure5_v_rhow.eps`	for $jj = 4, kk = 10$
O.A. Figure 13	`DMP_figures.m`	396	`figure5_v_capz.eps`	for $jj = 4, kk = 11$
O.A. Figure 14	`DMP_figures.m`	396	`figure5_v_monpol.eps`	for $jj = 4, kk = 12$
O.A. Figure 15	`DMP_figures.m`	396	`figure5_v_monpolCSC.eps`	for $jj = 4, kk = 13$
O.A. Figure 16	`DMP_figures.m`	239	`figure2_g_baseline.eps`	for $jj = 3, kk = 1$
O.A. Figure 17	`DMP_figures.m`	280	`figure3_g_baseline.eps`	for $jj = 3, kk = 1$
O.A. Figure 18	`DMP_figures.m`	239	`figure2_inv_baseline.eps`	for $jj = 6, kk = 1$
O.A. Figure 19	`DMP_figures.m`	280	`figure3_inv_baseline.eps`	for $jj = 6, kk = 1$
O.A. Figure 20	`DMP_figures.m`	239	`figure2_qq_baseline.eps`	for $jj = 7, kk = 1$
O.A. Figure 21	`DMP_figures.m`	280	`figure3_qq_baseline.eps`	for $jj = 7, kk = 1$
O.A. Figure 22	`DMP_figures.m`	396	`figure5_qq_monpol.eps`	for $jj = 7, kk = 12$
O.A. Figure 23	`DMP_figures.m`	396	`figure5_qq_monpolCSC.eps`	for $jj = 7, kk = 13$
O.A. Figure 24	`DMP_figures.m`	239	`figure2_psi_baseline.eps`	for $jj = 1, kk = 1$
O.A. Figure 25	`DMP_figures.m`	280	`figure3_psi_baseline.eps`	for $jj = 1, kk = 1$
O.A. Figure 26	`DMP_figures.m`	239	`figure2_a_baseline.eps`	for $jj = 2, kk = 1$
O.A. Figure 27	`DMP_figures.m`	280	`figure3_a_baseline.eps`	for $jj = 2, kk = 1$
O.A. Figure 28	`DMP_figures.m`	477	`w1_base.eps`	for $pp = 1$
O.A. Figure 29	`DMP_figures.m`	553	`w2_base.eps`	for $pp = 1$
O.A. Figure 30	`DMP_figures.m`	477	`w1_sSAMb.eps`	for $pp = 3$
O.A. Figure 31	`DMP_figures.m`	553	`w2_sSAMb.eps`	for $pp = 3$
O.A. Figure 32	`DMP_figures.m`	477	`w1_sSAMC.eps`	for $pp = 4$
O.A. Figure 33	`DMP_figures.m`	553	`w2_sSAMC.eps`	for $pp = 4$
O.A. Figure 34	`DMP_figures.m`	477	`w1_aSAMb.eps`	for $pp = 5$
O.A. Figure 35	`DMP_figures.m`	553	`w2_aSAMb.eps`	for $pp = 5$
O.A. Figure 36	`DMP_figures.m`	477	`w1_caput.eps`	for $pp = 42$
O.A. Figure 37	`DMP_figures.m`	553	`w2_caput.eps`	for $pp = 42$
O.A. Figure 38	`DMP_figures.m`	722	`w3_baseline.eps`	for $kk = 1$
O.A. Figure 39	`DMP_figures.m`	748	`w4_baseline.eps`	for $kk = 1$
O.A. Figure 40	`DMP_figures.m`	722	`w3_caputil.eps`	for $kk = 2$
O.A. Figure 41	`DMP_figures.m`	748	`w4_caputil.eps`	for $kk = 2$
O.A. Figure 42	`DMP_figures.m`	635	`w5_baseline.eps`	for $kk = 1$
O.A. Figure 43	`DMP_figures.m`	635	`w5_caputil.eps`	for $kk = 2$

4 Repository

The repository with the above described replication codes is available at `https://github.com/gergomotyovszki/DMP---monpol-and-CSC---replication-codes`

References

IRIS Solutions Team. 2015. "IRIS Toolbox Reference Manual." , (2015-01-27).

Schmitt-Grohé, Stephanie, and Martín Uribe. 2004. "Solving dynamic general equilibrium models using a second-order approximation to the policy function." *Journal of Economic Dynamics and Control*, 28(4): 755–775.