Replication package for 'House price dynamics, optimal LTV limits and the liquidity trap'

This file provides details of the replication codes for the paper 'House price dynamics, optimal LTV limits and the liquidity trap' by Andrea Ferrero, Richard Harrison and Benjamin Nelson.

1 Data Availability and Provenance Statements

Figures 1 and 2 in the paper use (publicly available) data which are stored in spreadsheets 'Figure1data.xlsx' and 'Figure2data.xlsx' in the 'Data' folder of the replication package. Details of the sources are listed below.

Figure 1

All series were downloaded from the St Louis Fed FRED database (`https://fred.stlouisfed.org/`). The series Mortgage debt (% of GDP) is the ratio between Mortgage Debt [1] and GDP [2]. The series Real house price index (2000Q1=100) is the ratio between House Prices [3] and the CPI [4]. These data are stored in columns B and C of the 'data' sheet of the `Figure1data.xlsx` Excel spreadsheet, which is located in the 'Data' folder within the replication package (see Section 3.1 for a description of the folder structure).

Figure 2

Figure 2 is constructed using the IMF's iMaPP Database [5]. The database is monthly from 1990 and codes macroprudential actions across 161 countries. To construct Figure 2, we calculate a simple sum and cumulative sum respectively of macroprudential LTV policy changes [6] across countries in the database.

The data for Figure 2 are contained in the `Figure2data.xlsx` Excel spreadsheet, which is located in the 'Data' folder within the replication package (see Section 3.1 for a description of the folder structure) and has the following structure:

- The iMaPP data are stored in the 'LTV' worksheet. This worksheet computes the number of LTV actions each month and the cumulative sum (columns FI and FJ). The three month sum is computed in column FL.
- Worksheet 'Quarterly' reports the three month sum (column FL in the 'LTV' worksheet) at a quarterly frequency.
- The 'ForMATLAB' sheet reads the data from the 'Quarterly' worksheet in a way that can be easily loaded into MATLAB. This is the data plotted in Figure 2.

References

1 **Board of Governors of the Federal Reserve System.** 1945–2016. "Households and Nonprofit organizations; Home mortgages; Liability, Level, Billions of Dollars, Quar-

terly, Seasonally Adjusted – HHMSDODNS". https://fred.stlouisfed.org/series/HHMSDODNS (accessed 10 April 2018).

2 **U.S. Bureau of Economic Analysis.** 1947–2016. "Gross Domestic Product, Billions of Dollars, Quarterly, Seasonally Adjusted Annual Rate – GDP" https://fred.stlouisfed.org/series/GDP (accessed 10 April 2018).

3 **U.S. Federal Housing Finance Agency.** 1975–2016. "All-Transactions House Price Index for the United States, Index 1980:Q1=100, Quarterly, Not Seasonally Adjusted – USSTHPI". https://fred.stlouisfed.org/series/USSTHPI (accessed 10 April 2018).

4 **U.S. Bureau of Labor Statistics.** 1947–2016. "Consumer Price Index for All Urban Consumers: All Items, Index 1982–1984=100, Quarterly, Seasonally Adjusted – CPIAUCSL". https://fred.stlouisfed.org/series/CPIAUCSL (accessed 10 April 2018).

5 **International Monetary Fund.** 1990–2016. "Integrated Macroprudential Policy (iMaPP) Database" https://www.elibrary-areaer.imf.org/Macroprudential/Pages/iMaPPDatabase.aspx (August 2021 vintage; accessed 3 November 2021).

6 **International Monetary Fund.** 1990–2016. "Limits to the loan-to-value ratios, applied to residential and commercial mortgages but also applicable to other secured loans, such as for automobiles. Other aspects of the LTV regulation are also covered, such as "speed limits" (i.e., a regulation on the percent of new loans that can go above certain LTV limits) – C9.LTV" https://www.elibrary-areaer.imf.org/Macroprudential/Pages/iMaPPDatabase.aspx (August 2021 vintage; accessed 3 November 2021).

2 Computational Requirements

The hardware, OS and software used is listed below (and the timings detailed in Section 3.2 refer to this configuration):

- CPU: Intel Core i7-8550U
- RAM: 16GB
- OS: Windows 10 Enterprise
- Software: MATLAB 2018b (64bit) with control system, optimization and symbolic math toolboxes installed and available.

The code has not been tested on other hardware, operating systems or software versions.

3 Replication Instructions

3.1 Replication package structure

The zip folder containing the replication scripts also contains the following folders:

- **Data** Excel spreadsheets with the data used to plot Figures 1 and 2 (see Section 1 for details).

- **Functions** Functions used to generate and plot the results.

- **MAPSlite** A (minimal) version of the 'Model Analysis & Projection System' (MAPS), developed at the Bank of England and described in Burgess et al. (2013).

- **Models** Text files containing the models used for the applications in Section 5 of the paper (in MAPS format).

- **Results** Results files for the experiments in the the paper are stored here.

- **Figures** Figure outputs (saved as ".eps" files) from the plotting codes.

- **Toolkit** The optimal policy toolkit of Harrison and Waldron (2021).

3.2 Replication of results in paper (and appendices)

The main scripts used to produce the results in the paper call the script `tidyUpAndSetPath.m`, which clears the workspace and adds the relevant paths for the functions. These are expressed relative to the working directory containing the scripts. This allows the relevant toolkits to be saved elsewhere as long as this script is altered accordingly.

The main folder of the replication package contains scripts to generate the results (saved in the 'Results' folder) and scripts to plot the figures in the paper. These are described in turn.

3.2.1 Scripts to generate the results

The two scripts used to generate the results in the paper and appendices should be executed in the following order (computation times reported to the nearest minute):

1. `doSimulationsUnderBaselinePolicy.m` This script runs the housing boom/bust simulation with baseline policy behavior and alternative assumptions:

   (a) A variant that imposes the zero lower bound on the monetary policy rate (computation time = 11 minutes).

   (b) A variant that does not impose the zero lower bound (computation time = 10 minutes).

   (c) A variant in which the collateral constraint is specified in terms of the expected value of housing (computation time = 15 minutes).

2. `doSimulationsWithAlternativePolicies.m` This script runs the housing boom/bust simulation under alternative assumptions about the conduct of policy. Several of these simulations use information from the baseline simulation results saved in step 1, which is why this script must be run second. The simulations produced are:

   (a) Jointly optimal time-consistent monetary and macro-prudential policy ('discretion') (computation time = 8 minutes).

(b) Jointly optimal monetary and macro-prudential policy under commitment (computation time = <1 minute).

(c) A variant of 2(a) with the collateral constraint expressed in terms of the expected value of housing (computation time = 6 minutes).

(d) Baseline policy implemented during the 'boom', switching to jointly optimal policy (as in 2(a)) during the 'bust' (computation time = <1 minute).

(e) Optimal time-consistent macro-prudential policy with the baseline Taylor rule for monetary policy (computation time = 8 minutes).

(f) An exogenous tightening in macro-prudential policy during the 'bust' (computation time = 1 minute).

(g) A variant of 2(f) without imposing the zero bound on the monetary policy rate (computation time = <1 minute).

(h) A variant of 2(d) without imposing the upper bound on the LTV limit (computation time = <1 minute).

(i) Baseline policy implemented during the 'boom', switching to optimal macroprudential policy and baseline monetary policy (as in 2(d)) during the 'bust' (computation time = <1 minute).

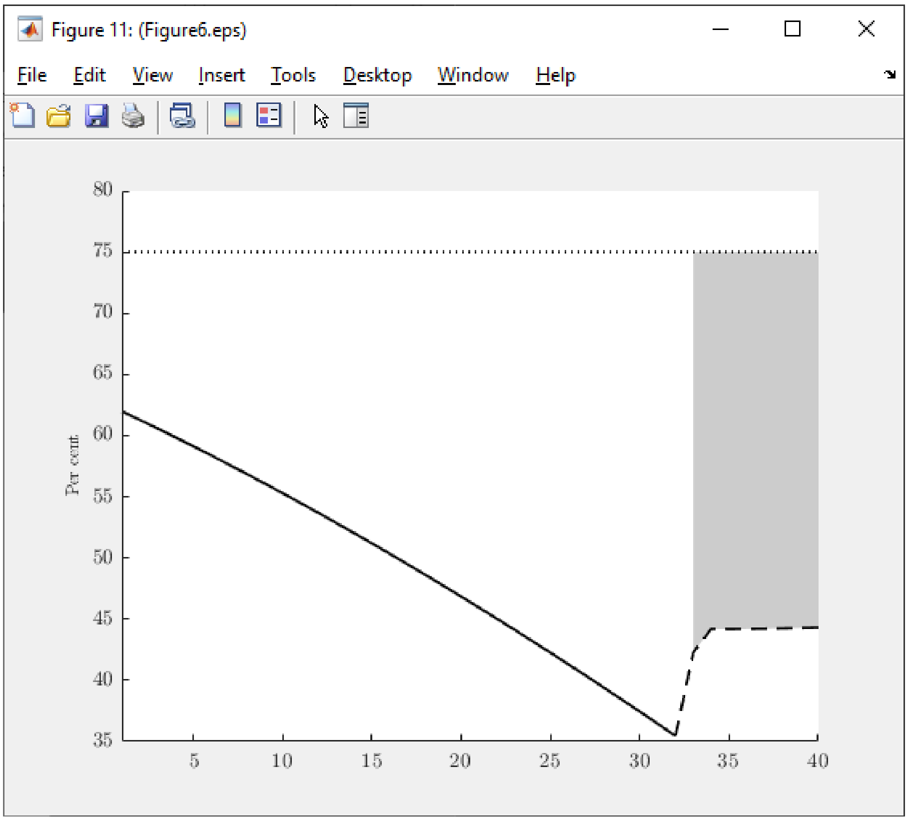
(j) A variant of 2(i) without imposing the upper bound on the LTV limit (computation time = <1 minute).

3.2.2 Scripts to produce the figures

The script `plotAllFigures.m` will plot all of the figures shown in the paper. Note that the figures are not produced in the same order as they appear in the paper (as the code is written to produce the figures efficiently). However, each figure is named by the eps or pdf file corresponding to the figure. So, for example, the 11th figure produced by the code is Figure 6 in the paper:

The script `plotAllFigures.m` works by running a set of scripts that produce a subset of the figures, each of which can be run individually if desired. For completeness the scripts are as follows.

Script	Figures produced
`plotFigure1.m`	1
`plotFigure2.m`	2
`plotFigure3.m`	3
`plotFigure9.m`	9
`plotFigure16.m`	16
`plotFigures_4_5_8_10_11_12_14.m`	4, 5, 8, 10, 11, 12, 14
`plotFigures_6_13.m`	6, 13
`plotFigures_7_15.m`	7, 15



References

Burgess, S., E. Fernandez-Corugedo, C. Groth, R. Harrison, F. Monti, K. Theodoridis, and M. Waldron (2013). The Bank of England's forecasting platform: COMPASS, MAPS, EASE and the suite of models. *Bank of England Staff Working Paper No. 471* (471).

Harrison, R. and M. Waldron (2021). Optimal policy with occasionally binding constraints: piecewise linear solution methods. *Bank of England Staff Working Paper No. 911*.