Readme File, Replication Package

Credit Shocks and Equilibrium Dynamics
in Consumer Durable Goods Markets

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January 2021

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1   Instructions for Replication

To replicate the results in the paper:

- In ./matlab_code/car_stock, run main_car_stock.m.

- In ./stata_code run price_restud.do and replacement_CEX.do.

- In ./matlab_code/analysis, run main_model_outputs.m

2   Files Description

2.1   Stata Codes

The Stata codes produce Figures 3, 4, and 5 of the paper. These Stata codes are in the ./stata_code/ folder. The user should change the startdir directory in the first few lines of each Stata .do file, all directories are relatives to startdir. A preliminary file restdu_installpackages.do installs some Stata packages.

- **Figure 3 and Figure 4.**

  The file price_restud.do calls two datasets included in the folder ./data/prices/: master_newprice_restud.dta and nada_restud.dta. The dataset master_newprice_restud.dta is the cleaned version of the Dominion dataset of new-car prices described in Appendix A; the dataset nada_restud.dta is the cleaned version of the NADA dataset of used-car prices described in Appendix A. In the process of producing Figures 3 and 4, the file price_restud.do performs some of the regressions described in Appendix A.

  The file price_restud.do produces the following subfigures that compose Figure 3: rep_DN_index.eps (top-left panel), rep_CIVIC_index.eps (top-right panel), rep_CAMRY_index.eps (bottom-left panel), and rep_ACCORD_index.eps (bottom-right panel). The code saves these files in the folder ./figures/.

  The file price_restud.do also produces the following subfigures that compose Figure 4: newused_DN_index.eps (top-left panel), newused_CIVIC_index.eps (top-right panel), newused_CAMRY_index.eps (bottom-left panel), and newused_ACCORD_index.eps (bottom-right panel). The code saves these files in the folder ./figures/.

- **Figure 5.**

  The file replacement_CEX.do calls the Consumer Expenditure Survey (CEX) datasets included in the folder ./data/cex/raw/.

  The file replacement_CEX.do produces Figure 5 as file households2y.eps, saving it in the folder ./figures/. The file replacement_CEX.do creates the folder ./data/cex/raw/derived/ in which several intermediate .dta files are saved; these intermediate files and the folder are deleted in the last lines of replacement_CEX.do.

2.2 Matlab Codes

All Matlab codes are in ./matlab_code/ and are organized in four sub-directories:

1. ./matlab_code/car_stock contains the code used to produce Figures 1 and 2.

2. ./matlab_code/analysis contains codes and data files used to produce Figures 6 through 17 and other quantitative results of the model described in the paper.

3. ./matlab_code/stationary contains codes and data related to the solution of the stationary equilibrium of the model.

4. ./matlab_code/transition contains codes and data files related to the solution of the transitional dynamics of the model.

2.2.1 Car Stock

The ./matlab_code/car_stock folder contains main_car_stock.m. This code produces **Figure 1** (autosales.eps) and **Figure 2** (scrappage.eps) by plotting the data series for new-car registrations and scrappage contained in car_stock_data.xlsx in ./data/car_stock. These figures are saved in ./figures/.

2.2.2 Analysis

The codes in ./matlab_code/analysis load the model simulated data and reproduce the model outputs. Specifically, main_model_outputs.m produces **Figures 6 through 17**, **Table 1**, and the statistics reported in Section 5.1 and Section 6.2.2., by sequentially running the following scripts:

- figures_ss_shocks.m produces Figures 6 (ss_thresholds.eps), 7 (shocks_phi_r.eps), 8 (shocks_phi.eps), 10 (shocks_PEp.eps), 13 (shocks_lambda0.eps), 14 (shocks_phiY.eps), 16 (shocks_coll.eps), and 17 (shocks_fiscal.eps).

- figures_decomp.m produces Figures 9 (shocks_decomp.eps) and 12 (shocks_perm_SOE.eps).

- figures_PE_Q.m produces Figure 11 (shocks_PE_Q.eps).

- figures_p1.m produces Figure 15 (shocks_phiY_p1.eps).

- table_cali.m produces Table 1 (Parameter Values) and saves it as Table_1.mat.

- stats_Sec_5_1.m produces the statistics described in the text of Section 5.1 using the simulation stored in sim_stats_base.mat.

- stats_Sec_6_2_2.m produces the statistics described in the text of Section 6.2.2 using the simulation stored in sim_stats_lambda0.mat.

All figures are saved in ./figures/.

Note that main_model_outputs.m loads the same data files used to produce the figures and statistics in the paper. While not necessary to reproduce the paper outputs, we also provide an alternative version of this file named main_model_outputs_solve.m that first saves a copy of these data files, and then re-computes the model solutions and new simulations of the transitional dynamics that are relevant for the paper figures and statistics (running codes described in the next subsections Stationary and Transition), before creating the figures and statistics as in main_model_outputs.m.

The code markov.m can be used to produce new household simulations in stats_Sec_5_1.m and in stats_Sec_6_2_2.m by un-commenting rows 16 and 17 and commenting row 19 in either of these files.

2.2.3 Stationary

The folder ./matlab_code/stationary contains codes that solve for the stationary equilibrium of the model, as well as the data files that are used to initialize the computation of the transitional dynamics (next subsection). Specifically, main_stationary.m solves for the stationary equilibrium of the baseline model in general equilibrium (Section 5), applying

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the solution method described in Appendix C.1. Results for the baseline model are stored in data files ss_smooth.mat (stationary equilibrium with borrowing limit $\phi = -1$) and ss_smooth_phi4.mat (stationary equilibrium with borrowing limit $\phi = -0.4$). The variable phi_vec on line 19 determines the selected value for the borrowing limit.

Other versions of the code for the stationary equilibrium are in the following files:

- main_stationary_PE.m, main_stationary_onlyq.m, main_stationary_onlyp.m compute special cases of the stationary equilibrium in which either both prices (bond price and price of used durables) are exogenous, or only one of the two prices is endogenous respectively. The results are stored in ss_smooth_phi4PE.mat, ss_phi4_PE_bmax15.mat, ss_onlyq.mat, ss_onlyp.mat, ss_smooth_phi4_onlyp_bmax15.mat.

- main_ss_lambda0.m solves for the stationary equilibrium of the model without transaction costs (Section 6.2.2). Results are stored in data files ss_lambda0.mat (stationary equilibrium with borrowing limit $\phi = -1$) and ss_phi4_lambda0.mat (borrowing limit $\phi = -0.4$).

- main_ss_collateral.m solves for the stationary equilibrium of the extended model with collateral constraint (Section 6.5). Results are stored in data files ss_coll_smooth.mat (stationary equilibrium with borrowing limit $\phi = -1$) and ss_coll_smooth_phi4.mat (borrowing limit $\phi = -0.4$).

The following codes are called in the solution of the stationary equilibrium.

- rouwenhorst.m discretizes AR(1) shock processes into Markov chains.

- goldenx.m and optget.m perform utility maximization using the golden search algorithm.

- F_tomax.m and F_tomax_car.m construct the maximand of the household utility maximization problem.

- solve_v.m computes the thresholds of the discrete choice problem over durable goods quality and performs the smoothing of the distribution of households described in Appendix C.3.

The folder also contains results for the baseline model with $\phi = -1$ with a wider grid for bonds, in file ss_bmax15.mat. This is obtained using main_stationary.m setting $b\_max = 15$ and $b\_n = 400$.

2.2.4 Transition

The folder ./matlab_code/transition contains codes that solve for the transitional dynamics of the model, as well as the related model-simulated data. Specifically, main_transition.m solves for the transitional dynamics of the baseline model in general equilibrium (Section 6.1), applying the solution method described in Appendix C.2. Results are stored in data file trans_smooth.mat.

Other versions of the code for the transitional dynamics are in the following files:

- main_transition_onlyphi.m, main_transition_PE_onlypsim.m, main_transition_PE_onlyqsim.m, main_transition_PE.m, main_transition_SOE_perm.m compute special cases of the transitional dynamics by only feeding the credit-shock series with constant prices, or only one price series at a time, or the shock and only one equilibrium price at a time respectively (specifically, the interest rate in main_transition_PE.m and the price of used durables in main_transition_SOE_perm.m) (Section 6.2.1).
  Results are stored in data files trans_perm_onlyphi.mat, trans_perm_onlyp.mat, trans_perm_onlyq.mat, trans_ trans_perm_SOE.mat, trans_smooth_PE.mat.

- main_transition_lambda0.m solves for the transitional dynamics in the model with no transaction costs (Section 6.2.2). Results are stored in data file trans_lambda0.mat.

- main_transition_Y98.m solves for the transitional dynamics in the model with aggregate income shock (Section 6.3). Results are stored in data file trans_smooth_Y98.mat.

- main_transition_p1.m solves for the transitional dynamics in the extended model with endogenous price of new durables (Section 6.4). Results are stored in data file trans_smooth_p1.mat.

- main_transition_coll.m solves for the transitional dynamics in the extended model with collateral constraint (Section 6.5). Results are stored in data file trans_coll.mat.

- main_transition_fiscal.m solves for the transitional dynamics with durable replacement stimulus (Section 6.6). Results are stored in data file trans_fiscal.mat.

The following codes are called in the solution of the transitional dynamics.

- trans_v.m solves the household optimization problem. trans_v_coll.m and trans_v_fiscal.m are the versions of this code for the model with collateral constraint and the model with durable-replacement subsidy respectively.

- trans_P.m and trans_P_g.m compute the transition matrix for the distribution of households.

- goldenx.m and optget.m perform utility maximization using the golden search algorithm.

- F_tomax.m and F_tomax_car.m construct the maximand of the household utility maximization problem.

- solve_v.m computes the thresholds of the discrete choice problem over durable goods quality and performs the smoothing of the distribution of households described in Appendix C.3.

3   List of Tables and Figures

- The Tables are created by the following files:

    1. ./matlab_code/analysis/table_cali.m

- The Figures are created by the following files:

    1. ./matlab_code/car_stock/main_car_stock.m
    2. ./matlab_code/car_stock/main_car_stock.m
    3. ./stata_code/price_restud.do.
    4. ./stata_code/price_restud.do.
    5. ./stata_code/replacement_cex.do.

6. ./matlab_code/analysis/figures_ss_shocks.m

7. ./matlab_code/analysis/figures_ss_shocks.m

8. ./matlab_code/analysis/figures_ss_shocks.m

9. ./matlab_code/analysis/figures_decomp.m

10. ./matlab_code/analysis/figures_ss_shocks.m

11. ./matlab_code/analysis/figures_PE_Q.m

12. ./matlab_code/analysis/figures_decomp.m

13. ./matlab_code/analysis/figures_ss_shocks.m

14. ./matlab_code/analysis/figures_ss_shocks.m

15. ./matlab_code/analysis/figures_p1.m

16. ./matlab_code/analysis/figures_ss_shocks.m

17. ./matlab_code/analysis/figures_ss_shocks.m

- Output Figures in the folder ./figures/

  1. autosales.eps

  2. scrappage.eps

  3. rep_DN_index.eps, rep_CIVIC_index.eps, rep_CAMRY_index.eps, and rep_ACCORD_index.eps.

  4. newused_DN_index.eps, newused_CIVIC_index.eps, newused_CAMRY_index.eps, and newused_ACCORD_index.eps.

  5. households2y.eps.

  6. ss_thresholds.eps.

  7. shocks_phi_r.eps.

  8. shocks_phi.eps.

  9. shocks_decomp.eps.

  10. shocks_PEp.eps.

  11. shocks_PE_Q.eps.

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12. shocks_perm_SOE.eps.

13. shocks_lambda0.eps.

14. shocks_phiY.eps.

15. shocks_phiY_p1.eps.

16. shocks_coll.eps.

17. shocks_fiscal.eps.

4 Data Availability Statement

The paper uses several datasets. Details of each dataset follow this list.

1. Car Stock

    - FILE: ./data/car_stock/car_stock_data.xlsx.

    - SOURCES: Stock of registered vehicles obtained from Federal Highway Administration (2017); new-vehicle sales obtained from U.S. Bureau of Economic Analysis (2017); new-vehicle leases obtained from Figure 6 of National Automobile Dealers Association (2015), available at `https://www.autonews.com/assets/pdf/NADA_Q4WhitePaper_NewVehicleLeasing-Facts,FiguresandFutureConsiderations.pdf`; scrappage based on authors' own calculations described in Section 3.

    - NOTES: Open Access.

    - PROVIDED: Yes.

2. New-Car Prices

    - FILE: ./data/prices/master_newprice_restud.dta.

    - SOURCE: Dominion Dealer Solutions (2019).

    - NOTES: Dataset is proprietary. To access the dataset, contact Angie Lena at `angie.lena@drivedominion.com`.

    - PROVIDED: We provide the anonymized and cleaned version of the data to construct Figures 3 and 4.

3. Used-Car prices

   - FILE: ./data/prices/nada_restud.dta.

   - SOURCE: National Automobile Dealers Association (2016).

   - NOTES: Dataset is proprietary. To access the dataset, contact Steve Stafford at `steve.stafford@nada.com`.

   - PROVIDED: We provide the anonymized and cleaned version of the data to construct Figures 3 and 4.

4. Consumer Expenditure Survey

   - FILES: Many files from the 2000-2015 surveys in the ./data/cex/raw/ folder.

   - SOURCE: U.S. Bureau of Labor Statistics (2013).

   - NOTES: Open Access.

   - PROVIDED: Yes.

5 Hardware and Software Requirements

1. Stata codes

   - We run the Stata codes on several different machines, most recently using Stata 15.0 for Unix on a x86_64 Dell Precision T7500 with Intel®Xeon®CPU E5540 @ 2.53GHz × 4 CPUs and Ubuntu 20.04.1 LTS.

   - The Stata codes require installing the ftools and reghdfe packages. "ssc install ftools" and "ssc install reghdfe" in the Stata command window will install them. They are also included in the restud_installpackages.do code.

   - The Stata codes run in less than one hour.

2. Matlab codes

   - We run the Matlab codes on several different machines, most recently using Matlab R2018a for Windows 64-bit on a Lenovo T450s with Intel®Core®i7-5600U CPU @ 2.60 GHz and Windows 10 Enterprise.

   - The Matlab codes run in less than one hour.

References

DOMINION DEALER SOLUTIONS (2019): "Data on New-Car Prices, 2004-2012," Norfolk, VA.

FEDERAL HIGHWAY ADMINISTRATION (2017): "Stock of Registered Vehicles, 2005-2014," Washington, D.C.

NATIONAL AUTOMOBILE DEALERS ASSOCIATION (2015): "New Vehicle Leasing: Facts, Figures and Future Considerations," White paper.

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