Contents

Replication Package for "Productive demand, sectoral comovement, and total capacity utilization"

Mario Rafael Silva, Marshall Urias

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1. Introduction

This package contains the code and data to replicate the results. Please not that Figures 2-4 relate only to the model structure, not data. Moreover, Table C.7 is just a set of prior distributions for a special case of the model.

2. Details of raw data and variable construction

2.1. Raw data

We list the data sources used in both description and estimation, grouped by source.

1. U.S. Bureau of Economic Analysis
    - Personal Consumption Expenditures: Nondurable Goods (PCND). Billions of Dollars, Seasonally Adjusted Annual Rate. Quarterly.
    - Personal Consumption Expenditures: Services (PCESV). Billions of Dollars, Seasonally Adjusted Annual Rate. Quarterly.
    - Personal Consumption Expenditures: Durable Goods (PCDG). Billions of Dollars, Seasonally Adjusted Annual Rate. Quarterly.
    - Private Nonresidential Fixed Investment (PNFI). Billions of Dollars, Seasonally Adjusted Annual Rate. Quarterly.
    - Personal Consumption Expenditures: Chain-type Price Index (PCEPI). Index 2017=100, Seasonally Adjusted. Monthly.
    - Gross Domestic Product: Implicit Price Deflator (GDPDEF). Index 2017=100, Seasonally Adjusted. Quarterly.
2. U.S. Bureau of Labor Statistics
    - Population Level (CNP16OV). Thousands of Persons, Not Seasonally Adjusted. Monthly.
    - Table B-6. Employment of production and nonsupervisory employees on private nonfarm payrolls by industry sector, seasonally adjusted. Extract Construction, Durable goods, Nondurable goods, Private service-providing.
    - Table B-7. Average weekly hours and overtime of production and nonsupervisory employees on private nonfarm payrolls by industry sector, seasonally adjusted. Extract Construction, Durable goods, Nondurable goods, Private service-providing.

3. Investment Deflator (INVDEF). Index 2012=100, Seasonally Adjusted. Quarterly. Source: DiCecio, Ricardo.

4. Board of Governors of the Federal Reserve System.

   - Capacity Utilization: Total Index (TCU). Percent, Seasonally Adjusted. Monthly.
   - Capacity Utilization: Durable Manufacturing (NAICS) (CAPUTLGMFDS). Percent, Seasonally Adjusted. Monthly
   - Capacity Utilization: Nondurable Manufacturing (NAICS) (CAPUTLGMFNS). Percent, Seasonally Adjusted. Monthly.

5. Utilizaton data from Fernald (2014). Federal Reserve Bank of San Francisco Working Paper 2012-19. https://doi.org/10.24148/wp2012-19

2.2. Variable construction

Appendix B in the main text details the construction of variables used in the paper given the raw data. For convenience, we summarize it below:

Symbol	Description	Construction
C	Nominal consumption	PCND+PCESV
I	Nominal gross private domestic investment	PCDG+PNFI+PRFI
$Deflator$	GDP Deflator	GDPDEF
Pop	Civilian non-institutional population	CNP160V
P_c	Price index: consumption	PCEPI
P_i	Price index: investment	INVDEV
c	Real per capita consumption	$\frac{C}{Pop*P_c}$
i	Real per capita investment	$\frac{I}{Pop*P_i}$
y	Real per capita output	$c+i$
n_c	Labor in consumption sector	Labor in nondurables and services
n_i	Labor in investment sector	Labor in construction and durables
n	Aggregate labor	n_c+n_i
p_i	Relative price of investment	P_i/P_c
$util_{ND}$	Total capacity utilization: nondurables	TCU
$util_D$	Total capacity utilization: durables	TCU
SR	Solow residual	Fernald (2014), FRB of San Francisco
SR_{util}	Utilization-adjusted Solow residual	Fernald (2014), FRB of San Francisco

Table 1: Data sources used in motivating evidence and estimation.

The construction of sectoral data follows Katayama and Kim (2018). We obtain consumption and investment as follows:

$$C_t = \left(\frac{Nondurable(PCND) + Services(PCESV)}{P_c \times CivilianNonstitutionalPopulation(CNP160V)} \right) \tag{1}$$

$$I_t = \left(\frac{Durable(PCDG) + NoresidentialInvestment(PNFI) + ResidentialInvestment(PRFI)}{P_i \times CivilianNoninstitutionalPopulation(CNP160V)} \right) \tag{2}$$

We use an HP-filtered trend for population ($\lambda = 10,000$) to eliminate jumps around census dates.

For labor data, we make use of BLS Table B6, which contains the number of production and non-supervisory employees by industry; and BLS Table B7, which contains average weekly hours of each sector. We compute total hours for nondurables, services, construction, and durables by multiplying the relevant components of each table. Then we impute labor in consumption as sum of labor in nondurables and services. Similarly, we construct labor in investment as sum of labor in construction and durables.

3. System Requirements

3.1. Software and Packages

- **MATLAB** R2023a or later, with Dynare 6.3
- **Python** 3.9 with packages: `numpy`, `pandas`, `scipy`, `matplotlib`, etc.
- **Julia** 1.10 with `Parameters`, `PlotlyJS`, `MAT`,`DataFrames`, `Distributions`, etc.

3.2. Hardware

Results were generated on a Dell Optiplex 7080, Windows 10 Enterprise, Intel Core i7, 32GB RAM.

4. Folder structure

The master folder contains a subfolder `Programs`, which in turn contains a subfolder `Estimation`.

- `Programs`: Contains two files
  - `observables.py`. Constructs data used for description and estimation. It generates the observables used for estimation in `observables_sectoral.mat`. This superset includes the set of observables used in the baseline model as well as the aggregate data used for the BRS proof of concept exercises. It also generates Table 1, Figure 1, Figure A.9, and Figure B.10.
  - `time_series_functions.py` This program contains a suite of functions related to filtering time series and calculating moments. In particular, we use the functions `moments`, `hamilton_filter`, `growth`, and `filter_transform`.

- `Estimation`. Includes the main estimation program `dynare_main.m` that runs results from multiple Dynare `.mod` files. The `.mod` files use the prefix `SU`, abbreviation of Silva and Urias or 'Sectoral Utilization'.

  - `dynare_main.m` `main_table.m`: generates output for Table 5
  - `FEVD_table.m`: calculates FEVD for grouped shocks (Table 4)
  - `decompose_demand.m`: disaggregates demand FEVD into specific demand shocks (Online Appendix Table 4)
  - `decompose_technology.m`: disaggregates technology FEVD into specific technology shocks (Online Appendix Table 5)
  - `SU_sectoral.mod`: benchmark estimation
  - `SU_sectoral_perfect_mobility`: allows perfect flexibility in labor supply.
  - `SU_sectoral_com_wage_markup`: uses a single wage-markup shock instead of them varying across consumption and investment sectors.
  - `SU_sectoral_wo_fixed_cost.mod`: removes fixed costs.
  - `SU_sectoral_wo_vcu`: removes variable capital intensity. That is, the capital stock is always used at a rate of unity.
  - `SU_sectoral_wo_dem_shocks`: removes search demand shocks
  - `SU_sectoral_wo_dem_shocks`: removes search demand shocks and the utilization variables from the set of observables.
  - `SU_sectoral_artificial_data.mod`: estimates model on artificial data generates from model with parameters set to posterior mean.
  - `SU_growth_id.mod`: estimation of BRS model, including estimation of parameters ϕ and η. Same set of observables used as BRS: $I, Y, Y/N, p_i$.
  - `SU_util.mod`: same model as `SU_growth_id.mod` but with set of observables extended to include total capacity utilization.

  For each of these files, there is a Dynare generated `.log` file recording the estimation results. Moreover, there is an associated folder with the same name generated by Dynare bearing the following subfolders: `graphs`, `latex`, `metropolis`, `modecheck`, `model`, `Output`, `prior`.

  The `.mod` files are organized as follows:

  - variable definitions with descriptions
  - exogenous processes
  - list of parameters
  - specification of parameter values
  - `model` block
    - dependent parameters specified via a #
    - main model equations
    - observation equations, which link model analogues to data

  - `steady_state_model` block. Calculates calibrated steady state sequentially. No external MATLAB file or numeric solver is necessary.
  - `shocks` block
  - `steady` and `check` blocks
  - `estimated_params` block. Specifies initial values and prior distributions.
  - `estimation` block. The most salient features are, in the case of the baseline:
    * `datafile=observables_sectoral`. Specifies data file containing observed series used for estimation.
    * `load_mh_file`. Instructs Dynare to load previous MCMC draws from disk.
    * `mcmc_jumping_variance=hessian`. Sets the initial covariance matrix for the MCMC proposal distribution to the inverse Hessian at the mode. Several alternate models use `prior_variance` instead.
    * `mode_compute=0`. Dynare does not compute the mode but instead uploads it.
    * `mh_replic=0`.Specifies the number of posterior draws. Here, we set 0 to just process existing draws.
    * `mh_nblocks=2`. Runs two chains in parallel for MCMC.
    * `mh_drop=0.3`. Fraction of initial MCMC draws to discard as burn-in.

This folder also contains the following Julia files:

- `calibration_cs`: calibrates the model given targets and generates Table 2 (Calibration). Since various parameters depend on estimated values, it utilizes the posterior mean from the baseline model.

- `bayesian_analysis.jl`: generates the impulses responses at the posterior mean (Figures 6-8) alongside Figure 5 (posterior and prior distributions).

5. Details of replication

5.1. Data construction and descriptive statistics

- All data, including the disaggregated capacity utilization series, can be fetched from the Federal Reserve Economic Database except for the sectoral labor hours. These are accessible from Tables B6 and B7 from the Bureau of Labor Statistics and are available in the file `sectoral_labor.csv`.

- Run `observables.py`. This generates a superset of the data used for estimation `observables_sectoral.mat` if one sets `save_observables = True`. Note that the baseline model uses `C_obs, I_obs, NC_obs, NI_obs, p_I_obs, util_D_obs, util_ND_obs`. The variables `Y_obs, Y_N_obs` are not used for the main sectoral analysis but instead for the BRS exercises.

  - Current specification `stoch_simul(order=1, nofunctions, irf=20, periods=0)` generates unconditional moments.
  - Switching `periods=223` generates artificial data of length 223 for the identification analysis. The artificial data is saved as `artificial_data.mat`.

- This file also generates Table 1 (second moments), Figure 1, Table 4 (FEVD), Figure B.10, and Figure A.9, and Online Appendix Tables 4 and 5.

5.2. Estimation

- Run `dynare_main.m` in batches to sequentially generate all the model results.
  - Run Part 1 to estimate the main model `SU_sectoral.mod`, saves output, and generates artificial data. The output is used to generate Tables 3 and Tables 4 and column 'Baseline' of Table 5.
  - Run Part 2 to estimate `SU_sectoral_perfect_mobility.mod`. Output is used for column 'Perfect labor mobility' in Table 5.
  - Run Part 3 to estimate `SU_sectoral_com_wage_markup.mod`. The output is used to generate column 'Common wage markup'. in Table 5.
  - Run Part 4 to estimate `SU_sectoral_wo_fixed_cost.mod`. The output is used to generate column 'Remove fixed cost' in Table 5.
  - Run Part 5 to estimate `SU_sectoral_wo_vcu.mod`. The output is used to generate column 'Remove VCU' in Table 5.
  - Run Part 6 to estimate `SU_sectoral_wo_demand_shocks.mod`. The output is used to generate column 'Remove SDS' in Table 5.
  - Run Part 7 to estimate `SU_sectoral_wo_dem_shocks_res.mod`. The output is used to generate column 'Remove SDS and utilization data' in Table 5.
  - Run Part 8 to estimate `SU_sectoral_artificial_data.mod`. The output is used to generate Table 3 in the Supplemental Online Appendix.
  - Run Part 9 to estimate `SU_growth_id.mod` and `SU_util.mod`. These correspond to specifications of the BRS model without and with utilization data. The output is used to generate Tables C.8 and C.9 of the Supplemental Online Appendix.
- For calibration, run `calibration_cs.jl` (generates Table 2).
- For posterior prior plots (Figure 5) and impulse responses (Figures 6-8), run `calibration_cs.jl`

References

Fernald, J. (2014): "A quarterly, utilization-adjusted series on total factor productivity," Citeseer.

Katayama, M., and K. H. Kim (2018): "Intersectoral labor immobility, sectoral comovement, and news shocks," *Journal of Money, Credit and Banking*, 50(1), 77–114.