The CMR Model

Code Reference Manual
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1 Introduction

This package is a collection of Dynare and matlab routines that implement the CMR model. The source code is distributed under the GNU General Public License, which is included in this document (see [GNU General Public License], page 10).

Any system with Matlab (version 7.0 or above) or GNU Octave (versions 3.0 to 3.4) and Dynare (version 4.2.1) should be able to use the code. Matlab must be purchased from MathWorks `http://www.mathworks.com/products/matlab/`. GNU Octave is free software and can be downloaded from `http://www.gnu.org/software/octave/`. Dynare is also free software and can be downloaded from `http://www.dynare.org/`.

The code provided has no warranty. The code is provided "as is".

1.1 Installation

The model code must be in the current working directory of Matlab or Octave. To see the name of the current working directory, issue the command

```
>> pwd
```

To see the names of the files in the current working directory, issue the command

```
>> ls
```

To change directories, use the `cd` command. The current working directory must contain a directory named `dynare_code` with the files that are included in this package in a directory of the same name.

1.2 Using Dynare

The library requires that the `dynare` be installed. In particular, Matlab or Octave must be able to find the `dynare` program. Use the `addpath` command to add the path to the installation of Dynare. To ensure that Matlab or Octave can find `dynare`, issue the command

```
>> which dynare
```

If Matlab returns `'dynare' not found.`, the path to Dynare has not been added.

2 Using the Code

The analysis of the model will be carried out by the command

```
>> dynare cmr.mod
```

The simplicity of the calling command masks the files required to analyze the model. The requisite files are described here.

2.1 Model Files

This section describes files specific to the CMR model.

2.1.1 cmr.mod

The file `cmr.mod` serves as the main file for the model. The file makes extensive use of the `@# include` command, which inserts code from other files. The reason to keep the code in separate files is for ease of maintenance, comprehension, and use. This file has sections zero through six.

- **Section 0** contains housekeeping commands, like `addpath`.
- **Section 1**, includes the declarations using the `var`, `varexo`, and `parameters` commands. These declarations are kept in the file `cmr_declarations.mod`.
- **Section 2** calibrates initial values of the parameters. The initial values are kept in the file `cmr_parameters.mod`, which is included in `cmr.mod` using the `@# include` command. Changes to the active shocks may be made in `cmr.mod` by changing macro variables defined in this section.
- **Section 3** includes the equations characterizing equilibrium of the model. That is, it contains the `model` block. The equations are kept in the file `cmr_model.mod`, which is included in `cmr.mod` using the `@# include` command.
- **Section 4** includes the commands needed for estimation.
  - The `shocks` block is contained in the file `cmr_shocks.mod`, which is included in `cmr.mod` using the `@# include` command.
  - Priors for the estimated parameters are declared in the `estimated_params` block. This block is contained in the file `cmr_estimated_params.mod`, which is included in `cmr.mod` using the `@# include` command.
  - Initial values of the estimated parameters are declares in the `estimated_params_init` block. This block is contained in the file `cmr_estimated_params_init.mod`, which is included in `cmr.mod` using the `@# include` command.
  - The `varobs` command declares the observable variables.
  - The command `options_.weibull = 1;` enables Weibull priors. The command `options_.plot_priors = 0;` ensures that priors are not plotted.
  - Finally, the `estimation` command conducts estimation. In the baseline setup, the `estimation` command requires that the observable data be stored in a file named `cmr_data_GZ.mat` and that the mode be stored in a file named `cmr_mode.mat`.
- **Section 5** runs the stochastic simulation using the `stoch_simul` command.
- **Section 6** processes the results from the analysis by including the file `cmr_process_results.mod`.

2.1.2 cmr_declarations.mod

The file `cmr_declarations.mod` declares variables using the `var`, `varexo`, and `parameters` commands. More information about these commands can be found at http://www.dynare.org/manual/index_12.html. This file is included in `cmr.mod` using the `@# include` command.

2.1.3 cmr_estimated_params.mod

The file `cmr_estimated_params.mod` declares priors for the estimated parameters in the `estimated_params` block. More information about the `estimated_params` block can be found at http://www.dynare.org/manual/index_24.html#index-estimated_005fparams. This file is included in `cmr.mod` using the `@# include` command.

2.1.4 cmr_estimated_params_init.mod

The file `cmr_estimated_params_init.mod` declares initial values of the estimated parameters in the `estimated_params_init` block. More information about the `estimated_params_init` block can be found at http://www.dynare.org/manual/index_24.html#index-estimated_005fparams_005finit. This file is included in `cmr.mod` using the `@# include` command.

2.1.5 cmr_parameters.mod

The file `cmr_parameters.mod` calibrates initial values of the parameters. This file is included in `cmr.mod` using the `@# include` command.

2.1.6 cmr_process_results.mod

The file `cmr_process_results.mod` processes the results from the analysis. For example, it contains commands to produce desired statistics or graphics. This file is included in `cmr.mod` using the `@# include` command.

2.1.7 cmr_shocks.mod

The file `cmr_shocks.mod` declares the shocks in the `shocks` block. More information about the `estimated_params_init` block can be found at http://www.dynare.org/manual/index_18.html. This file is included in `cmr.mod` using the `@# include` command.

2.1.8 cmr_steadystate.m

The file `cmr_steadystate.m` computes the steady state of the model. This is called by numerous Dynare routines.

2.1.9 cmr_data_GZ.mat

The file `cmr_data_GZ.mat` contains the observation data. The names must be the same as those used in the `varobs` command.

2.1.10 cmr_mode.mat

The file `cmr_mode.mat` contains a custom mode of the posterior of the model parameters so that it need not be computed.

2.2 Custom Dynare Files

This package includes a directory named `dynare_code` that contains several custom dynare files. The files are listed below with a brief description of the reason they are included. Please note that the copyright of these files remains with the Dynare Team. As permited by the Dynare Team, these files are distributed under version 3 of the GNU General Public License (see [GNU General Public License], page 10).

2.2.1 draw_prior_density.m

The file `draw_prior_density.m` is modified to allow the Weibull prior when `options_.weibull = 1`.

2.2.2 priordens.m

The file `priordens.m` is modified to allow the Weibull prior when `options_.weibull = 1`.

2.2.3 disp_th_moments.m

The file `disp_th_moments.m` is modified to allow several variables of interest to be returned as return values.

2.2.4 dynare_estimation_1.m

The file `dynare_estimation_1.m` is modified to skip `initial_estimation_checks`. The reason is that the checks sometimes fail for reasons that are not problematic for the model.

2.2.5 set_prior.m

The file `set_prior.m` is modified to allow the Weibull prior when `options_.weibull = 1`.

3 Coding Standards

Though none of these coding standards are required to implement the model, they are intended to improve readability and maintainability of the code. The standards are described here to help the reader understand the naming conventions as well as other decisions made with regard to the code's style.

3.1 Declarations

Declarations of variables and parameters using the `var`, `varexo`, and `parameters` commands should occur on separate lines for each parameter or variable. Additionally, parameter and variables names should be alphebatized in the declaration. For example,

```
var
x,
y,
z;
```

3.2 Names

For continuity, distinctions are made regarding the way objects are named.

3.2.1 Variables

Variables declared in the `var` command should have names consisting only of letters and numbers. Additionally, the names should be reflective of the symbols used for the same concept in the manuscript. Underscores are explicitly omitted. This keeps the length of variable names from getting so long that the model block becomes unwieldy. It also gives the underscore particular meaning when naming other objects.

3.2.2 Parameters

Parameters declared in the `parameters` command should have names that consist of letters and numbers followed by an `_p`. The `_p` makes parameters explicit when defining model equations.

3.2.3 Exogenous Variables

Exogenous variables declared in the `varexo` command should have names that begin with `e_` and then consist of only letters and numbers. The `e_` makes exogenous variables explicit when defining model equations.

3.2.4 Observable Variables

Observable variables declared in the `varobs` command should be appended with `_obs`. This makes clear the observation equations in the model.

3.3 Model-Local Variables

When model-local variables are defined in the model block with the `#` command, use the same conventions as for other names. However, because these expressions are pasted as text strings into the model file, the variables cannot be indexed by time and it is often necessary to define a one-step-ahead or one-step-behind version of the variable. In that case, append a `p1` to the end to indicate one step ahead or `m1` to indicate one step behind. Additionally, when defining a model-local variable, the entire expression on the right-hand-side of the equals sign should be enclosed in a set of parentheses. This ensures that the entire block of code will be multiplied, exponentiated, etc. when pasted in to the model block by the preprocessor.

3.4 Spacing of Model Equations

The arithmetic expressions `+`, `-`, `*`, `/`, and `=` should be preceeded and followed by one space. It is occasionally acceptable add additional spaces before or after these operators in order to align similar equations. Additionally, for expressions within exponents it is acceptable to omit the spaces for ease of readability. Left parentheses should not be followed by a space. Similarly, right parentheses should not be preceeded by a space. The expression `^` should not be preceeded by or followed by a space.

3.5 Line Length

Code should be limited to 75 characters per line. The lone exception is in the model block, where equations are often more readable when allowed to exceed this limit. If more than one line is used for a single equation in the model block, new lines should begin with a `+`, `-`, `*`, or `/`.

4 Name Index

Names used in the code are here matched to their concepts in the manuscript.

4.1 Endogenous Variable Names

`c`	$c_t \equiv C_t/z_t^*$, scaled aggregate consumption
`epsil`	ϵ_t, technology shock
`Fp`	$F_{p,t}$, convenience variable for price evolution
`Fw`	$F_{w,t}$, convenience variable for wage evolution
`g`	$g_t \equiv G_t/z_t^*$, scaled government purchases
`gamma`	γ_t, equity shock
`h`	h_t, hours
`i`	$i_t \equiv I_t/z_t^* \Upsilon^t$, scaled investment
`kbar`	$\bar{k}_{t+1} \equiv \bar{K}_{t+1}/z_t^*$, scaled entrepreneurial capital
`lambdaf`	$\lambda_{f,t}$, intermediate goods shock
`lambdaz`	$\lambda_{z,t}$, marginal utility of consumption
`muup`	$\mu_{\Upsilon,t}$, investment goods technology shock
`muzstar`	$\mu_{z^*,t}$, growth rate of z_t^*
`n`	n_t, entrepreneurial net worth
`omegabar`	$\bar{\omega}_t$, the ω separating bankrupt and non-bankrupt entrepreneurs
`phi`	ϕ, fixed cost that ensures zero profits
`pi`	$\pi_t \equiv P_t/P_{t-1}$, inflation
`pitarget`	π_t^{target}, inflation rate in the monetary authority's policy rule
`pstar`	p_t^*, useful variable in pricing equations
`q`	$q_t \equiv \Upsilon^t Q_{\bar{K}',t}/P_t$, scaled market price of capital
`Re`	R_t, risk-free rate of interest
`rL`	real-risk-free-10-year rate of interst
`rk`	r_t^k, rental rate of capital
`Rk`	R_t^k, return on capital
`RL`	nominal-risk-free-rate-10-year rate of interest
`s`	s_t, marginal cost
`sigma`	σ_t, risk shock
`term`	term structure of interest rates

`u` u_t, utilization rate of capital

`wtilde` $\tilde{w}_t$, scaled real wage

`wstar` w_t^*, useful variable in wage equations

`xi0, xi1, xi2, xi3, xi4, xi5, xi6, xi7, xi8`
$\xi_{0,t}, \xi_{1,t}, \xi_{2,t}, \xi_{3,t}, \xi_{4,t}, \xi_{5,t}, \xi_{6,t}, \xi_{7,t}, \xi_{8,t}$, news shocks

`zetac` $\zeta_{c,t}$, preference shock on consumption

`zetai` $\zeta_{I,t}$, maginal efficiency of investment

4.2 Observable Variable Names

`consumption_obs`
$c_t \mu_{z^*,t}/(c_{t-1}\mu_{z^*})$,

`credit_obs`
$(q_t * \bar{k}_t - n_t)/(q_{t-1}\bar{k}_{t-1} - n_{t-1})\mu_{z^*,t}/\mu_{z^*}$

`gdp_obs` $(c_t + i_t/\mu_{\Upsilon,t} + g_t)\mu_{z^*,t}/(c_{t-1} + i_{t-1}/\mu_{\Upsilon,t-1} + g_{t-1})/\mu_{z^*}$

`hours_obs`
h_t/h

`inflation_obs`
π_t/π

`investment_obs`
$i_t \mu_{z^*,t}/(i_{t-1}\mu_{z^*})$

`networth_obs`
$n_t \mu_{z^*,t}/(n_{t-1}\mu_{z^*})$

`pinvest_obs`
$\mu_{\Upsilon,t-1}/\mu_{\Upsilon,t}$

`premium_obs`
`Re_obs` $\exp(Re - Re_p)$

`RealRe_obs`
$((1 + R_t)/\pi_{t+1})/((1 + R)/\pi)$

`Spread1_obs`
$1 + RL_t - R_t$

`wage_obs` $\tilde{w}_t \mu_{z^*,t}/(\tilde{w}_{t-1}\mu_{z^*})$

4.3 Exogenous Variable Names

The endogenous variables ϵ_t, g_t, γ_t, $\lambda_{f,t}$, $\mu_{\Upsilon,t}$, $\mu_{z^*,t}$, π_t^{target}, σ_t, $term_t$, $\zeta_{c,t}$, and $\zeta_{i,t}$ have an AR(1) representation. When an exogenous variable is the shock to one of those variables in the AR(1) representation, we will call it a shock to that variable.

`e_epsil` shock to ϵ_t

`e_g` shock to g_t

`e_gamma` shock to γ_t

`e_lambdaf`
shock to $\lambda_{f,t}$

`e_muup` shock to $\mu_{\Upsilon,t}$

`e_muzstar`
shock to $\mu_{z^*,t}$

`e_pitarget`
shock to π_t^{target}

`e_sigma` shock to σ_t

`e_xi1, e_xi2, e_xi3, e_xi4, e_xi5, e_xi6, e_xi7, e_xi8`
shocks to $\xi_{0,t}, \xi_{1,t}, \xi_{2,t}, \xi_{3,t}, \xi_{4,t}, \xi_{5,t}, \xi_{6,t}, \xi_{7,t}, \xi_{8,t}$

`e_term` shock to $term_t$

`e_xp` monetary policy shock

`e_zetac` shock to $\zeta_{c,t}$

`e_zetai` shock to $\zeta_{i,t}$

4.4 Parameter Names

actil_p, adptil_p, adytil_p, alpha_p, aptil_p, aytil_p, b_p, beta_p, bigtheta_p, btot_p, c_p, consumption_obs_p, credit_obs_p, delta_p, duration1_p, etag_p, epsil_p, Fomegabar_p, Fp_p, Fw_p, g_p, gamma_p, gdp_obs_p, h_p, hours_obs_p, i_p, inflation_obs_p, investment_obs_p, iota1_p, iotaw1_p, iotamu_p, kbar_p, lambdaz_p, lambdaf_p, lambdaw_p, mu_p, muup_p, muzstar_p, n_p, networth_obs_p, omegabar_p, par8_p, pi_p, pibar_p, pinvest_obs_p, pitarget_p, premium_obs_p, psik_p, psil_p, psiL_p, pstar_p, q_p, Re_p, Re_obs_p, rhoepsil_p, rhog_p, rhogamma_p, rholambdaf_p, rhomuup_p, rhomuzstar_p, rhopitarget_p, rhosigma_p, rhoterm_p, rhotil_p, rhozetac_p, rhozetai_p, rk_p, Rk_p, s_p, Sdoupr_p, sigma_p, sigmaa_p, sigmaL_p, Spread1_obs_p, stdepsil_p, stdg_p, stdgamma_p, stdlambdaf_p, stdmuup_p, stdmuzstar_p, stdpitarget_p, stdsigma1_p, stdsigma2_p, stdterm_p, stdxp_p, stdzetac_p, stdzetai_p, tauc_p, taud_p, tauk_p, taul_p, term_p, tauo_p, u_p, upsil_p, w_p, wage_obs_p, we_p, wstar_p, xip_p, xiw_p, zeta_p, zetac_p, zetai_p;

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