PROTO Model: Implementation in GEMPACK

Sugandha D Tuladhar

September, 1997

1. Description of the PROTO Model

The PROTO model consists of a representative consumer, a producer and a government sector. The consumer maximizes its utility subject to the budget constraint. The consumer makes a choice between consumption of a single composite commodity and leisure. Apart from the straight wage the consumer also receives subsidy from the government. The producer minimizes the total cost subject to the technology constraint. The government runs a balanced budget program.[1] The model yields ten equations. The model is further reduced to seven equations through appropriate substitutions, see section-2.

Household Problem

$$\max\ C^{a} J^{1-a}$$

subject to

$$P.(1+\tau).C \leq W.L^{s} + S$$

$$L^{s} + J = H$$

Firm Problem

$$min\ P.X + W.L^{d}$$

subject to

$$Q = min\ \{b.X,\ b.L^{d}\}$$

Government Problem

$$T.P.C = S$$

Market Clearing

$$L^{s} = L^{d}$$

$$Q = C + X$$

Identity Equation

$$Y = W.H + S$$

The model variables and the parameters are:

Endogenous variables:

Y: *Full Income*

W: *Wage*

[1]Here no attempts are made to justify the choosen functional forms. The choice is based on purely convenience sake.

C: *Consumption*

S: *Subsidy*

P: *Price*

L^d: *Labor Demand*

L^s: *Labor Supply*

J: *Leisure*

Q: *Output*

X: *Intermediate Input Demand*

Exogenous variables:

H: *Endowment of Time*

t: *Tax on consumption Parameters*

a: *Utility Parameter*

b: *Production Parameter*

2. Implementation in GEMPACK

Generation of the Baseline Solution and running experiments in GEMPACK for the PROTO model involves the following eight steps.

Step 1: Download the program files and the relevant files

Step 2: Prepare initial input guessfile file

Step 3: Run TABLO and GEMSIM to calculate the slack values

Step 4: Run simulation on the slacks

Step 5: View the Baseline Solution

Step 6: Homogeneity tests

Step 7: Run an experiment

Step 8: Prepare simulation results

Steps 1 through 5 describes the Baseline calculation and steps 6, 7, and step 8 describes GEMPACK procedures to run various experiments. The flow charts for the procedures are shown in figure 1,2, and figure 3 in appendix-1.

Step 1: Download the program files and the relevant files

Download to an empty directory http://www.eco.utexas.edu/~wilcoxen/cge/baseline.zip. Unzip the file which contains the following eleven files. The files are also attached in the appendix.

1. guessfile.txt

2. guessfile.sti
3. slackcal.tab
4. slackcal.sti
5. sim.tab
6. baseline.cmf
7. baseline.sti
8. homog.cmf
9. homog.sti
10. simtau.cmf
11. simtau.sti

Step 2: Prepare initial input guessfile file

The first step is to prepare a text file containing the initial guess of the endogenous variables, exogenous variables and the parameters.[2] Initial guesses for the endogenous and exogenous variables are specified in the text file *guessfile.txt*. Although data files can be read in as a text file, the choice for holding the data in GEMPACK is header array file.[3] The user inputs for converting the text file into header array file is given below.[4]

Your selection > `MODHAR`
`sti`
`guessfile.sti`

Step 3: Run TABLO and GEMSIM to calculate the slack values

The TABLO file, *slackcal.tab*, is the program file that calculates the slack values. TABLOX generates the FORTRAN files for GEMSIM program to use.[5] GEMSIM program calls all the relevant data files into the file generated by TABLOX and calculates the slack values; which is then stored in a header array file named *slackfile*. The user input for TABLOX and GEMSIM is as follows.

Your selection > `TABLOX` *`slackcal.tab`*
`GEMSIM`

---

[2]As mentioned in section 2, the potential initial guesses candidate would be the present values of the economy. However, for the models illustrated in this document we will take some random initial guesses.

[3]GEMPACK USER DOCUMENTATION, Release 5.1 Vol 1, page 3-24. see also "How to Create and Modify GEMPACK Header Array Files Using the Program MODHAR", GEMPACK Document No. 3

[4]All the inputs are in `Courier New` font. The upper case indicates that the input is GEMPACK program file. The italic inputs are one of the downloaded file.

[5]TABLOX program generates the program in a linearized form.

```
sti
slackcal.sti
```

Step 4: Run simulation on the slacks

The objective of this step is to run an experiment where the slacks are decreased by 100 percent. The TABLO file, *sim.tab*, specifies the model and pointers to files to be read in. The file, *sim.tab*, captures the theory of the model. The GEMPACK program GEMSIM specifies the data files to be read in, types of variables, and the model closure.[6] All the information needed for the GEMSIM program is fed in through a command file, *baseline.cmf*. The solution to the simulation, in percentage change, is written in the file *baseline.sl4*. The baseline solution or the updated file for the simulation is written to the header file *baseline*. The user inputs for this step is illustrated below.

```
Your selection > TABLOX sim.tab
                 GEMSIMX baseline.cmf
```

Step 5: View the Baseline Solution

The solution of the original model is stored in the header file specified in the command file. SEEHAR converts the header array file into a text file. The user input to view the baseline solution is illustrated below.

```
Your selection > SEEHAR
                 sti
                 baseline.sti
```

The baseline solution is stored in a text file *baseline.txt*. The solution for the PROTO model, is shown in the table 1 below. The detail output is attached in appendix

Table 1 : Baseline Solution

Endogenous Variable	Baseline Solution
C	25.9318
J	75.0664
L	24.9346
P	1
Q	50.8666
S	5.18635
W	1.0400
Y	109.186

[6]GEMPACK USER DOCUMENTATION, Release 5.1, page 2-3

GEMPACK also stores the solution in percentage change. The percentage change solution file for PROTO, *baseline.sl4*, can be viewed as a text file by running GEMPACK program GEMPIE. The output from the GEMPIE is written to *baseline.pi5*. However at this instance we are interested only in the baseline solution or the solution in levels.

Step 6: Homogeneity Test

Homogeneity test is a method to check the validity of the model. The test for the PROTO model is accomplished in GEMPACK by running a simulation in which the price of the consumption good, the numeraire, is increased by 100 percent. The PROTO model is valid if the result from this simulation indicates that income, wage and subsidy increased by 100 percent and consumption, labor, leisure and output remained the same. As mentioned in the above section, the solution can also be viewed in percentage change. GEMPIE program is used to view the solution file in percentage change as a text file.

The procedure for running this experiment is similar to the slack experiment for calculating the baseline solution. The only different is the shock specification in the command file. The user input to perform the experiment and to view the homogeneity results are shown below.

```
Your selection > GEMSIMX homog.cmf
                 GEMPIE
                 sti
                 homog.sti
```

The results from this homogeneity experiment are shown in the table below. The result indicates that the percentage changes of the variables are approximately equal to the expected result. The small errors are due to numerical precision.

Table 2: Homogeneity Results

Endogenous variable	Expected Percent Change (%)	Percent Change (%)
P	-	100
Y	100	99.999939
W	100	100
S	100	99.999962
C	0	-0.000006
L	0	-0.000510
J	0	-0.000581
Q	0	-0.000510

Step 7 & 8: Simulation and view the results

The Baseline solution gives the starting point for all the simulations. Given the baseline solution, simulations in GEMPACK amount to only changing the model closure and the shock file. Let the present experiment be to increase the tax on consumption from the present value of 0.2 to 0.3. This experiment amounts to 50 percent increase in the TAU variable. The procedure to invoke the simulation and to view the solution is as follows.

```
Your selection > GEMSIMX simtau.cmf
                 GEMPIE
                 sti
                 simtau.sti
```

The results of the tax simulation are be tabularized below and GEMPACK output is attached in appendix.

Table 3: Simulation Results

Endogenous Variable	Baseline	Simulation Results	
		Percent Change	Level Value
TAU	0.2	50	0.3
Y	109.186	1.955610	111.322
W	1.04000	0	1.04000
S	5.18635	41.170773	7.32161
C	25.9318	-5.887420	24.4050
L	24.9346	-5.887366	23.4666
J	75.0662	1.955590	76.5344
Q	50.8665	-5.887364	47.8719

To run other simulations, one needs to change the model closure and the shock specification in the GEMSIM command file. The advantage of using GEMPACK lies in performing simulation very quickly, given an initial baseline solution.

Appendix-1

Figure 1:

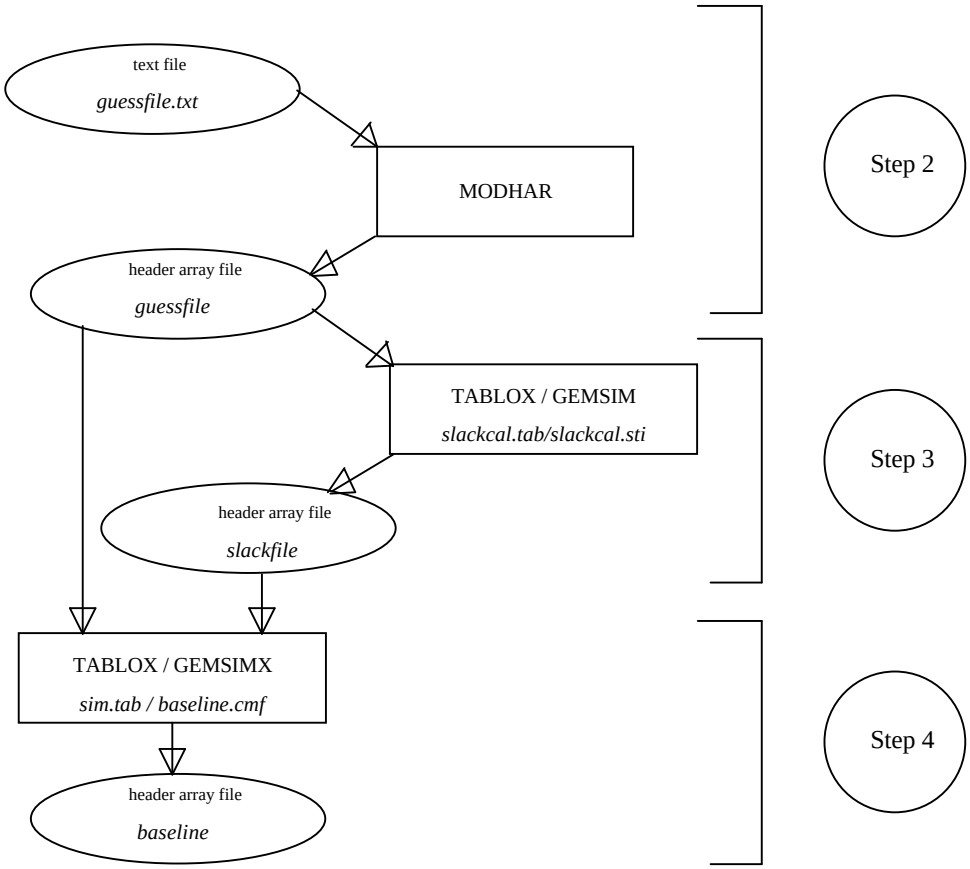

Figure 2:

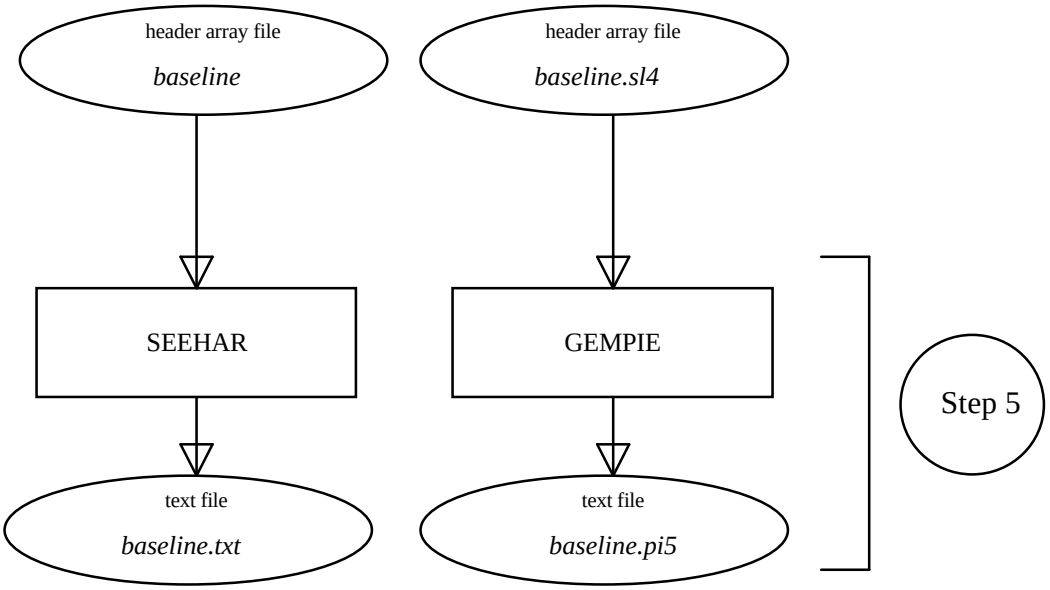

Figure 3: