Using a Spreadsheet SAM for GAMS CGE Modeling

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Abstract
This technical document provides in a single document a template to follow when using spreadsheet Social Accounting Matrix data to drive a GAMS-based Computable General Equilibrium model.

Problem Context
GAMS (General Algebraic Modeling System) software is widely used to run CGE (Computable General Equilibrium) models. The Social Accounting Matrix (SAM) database used in CGE models can be prepared using several methods, but it is a common practice to set it up on a spreadsheet in order to facilitate its manipulation and subsequent modifications and simulation exercises. Although there are several sources of information (Forums, Manuals, etc.) on how to import data from spreadsheets (e.g. Excel (*.xls, *.xlsx files)) to GAMS and how to set up a CGE model, it is difficult to find a single document that combines both, in a sense providing a template for new modelers to follow. This tech document fills that gap, drawing upon a variety of sources as noted in the reference list.

Social Accounting Matrix
The SAM can be summarized as in Figure 1:

Composition of each SAMs component are as follows:

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Figure 1: Social Accounting Matrix

<table>
<thead>
<tr>
<th>Industries</th>
<th>Commodities</th>
<th>Factors</th>
<th>Institutions</th>
<th>Trade</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industries</td>
<td>Make Matrix</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commodities</td>
<td>Use Matrix</td>
<td></td>
<td>Domestic Commodity Consumption</td>
<td></td>
<td>Domestic Commodity Output</td>
</tr>
<tr>
<td>Factors</td>
<td>Value Added</td>
<td></td>
<td></td>
<td></td>
<td>Value Added</td>
</tr>
<tr>
<td>Institutions</td>
<td></td>
<td></td>
<td>Domestic Commodity Sales</td>
<td>Factor Services Exports</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Factor Services Imports</td>
<td></td>
<td>Inter-Institutional Transfers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade</td>
<td>Commodity Import</td>
<td></td>
<td>Factor Outlay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Industry Output</td>
<td></td>
<td>Domestic Commodity Output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Weisskoff (2000). Note: on gray are the ones which need to be filled in to run CGE models.

- Industries and Commodities: list of industries and commodities considered;
- Factors: labor, capital, taxes, etc.;
- Institutions: households, firms, government, etc.;
- Trade: domestic and foreign;

**GAMS**

A program in GAMS can be organized in two styles according to Rosenthal (2014. Figure 2 presents the schematics of Style 1. This documents intends to deal only with the first section Data, in which the sets used in the model and parameters are defined and the SAM table is loaded.

Some general notes on GAMS are:

1. GAMS syntax is not case sensitive;
2. Declaration of a set or parameter means that we are declaring its existence; Definition or Assignment means to establish a value or a form;

3. It is good to end every statement by a semi-colon (;); This avoids unexpected errors;

4. Using an asterisk (*) in the first character of a line makes it a comment, so it won’t be interpreted as part of the code.

**Supporting Algorithm(s)/Code**

```
**************************************************************
****** GAMS PROGRAM: CGE MODEL USING SPREADSHEET SAM ******
**************************************************************

**************************************************************
****** DATA ******
**************************************************************
```
** This is the first part of a GAMS program. It should include **
** every SET and PARAMETER with its declaration and definition. **
** Also here the assignment of benchmark variables and **
** parameters are made. **
**************************************************************************************

**************************************************************************************
********* SETS AND PARAMETERS *********
**************************************************************************************

********

****** SETS DEFINITION ******

** In this section all SETS are declared and defined. Notes: **
** i) the name of each sectors (SEC) should match the name **
** given in the spreadsheet document **
** ii) The function Alias is used to repeat a set with another **
** name without having to declare it again **
** iii) The variable part of the program, i.e., the part it has **
** to be adapted to each case, is between quotation marks (" ") **
**************************************************************************************

SET
SEC All
"List of all columns (rows) you have and its description"/

A(SEC) Activities
"List of industries and its description"/

C(A) Commodities
"List of commodities and its description"/

I(SEC) Institutions
"List of institutions and its description"/

T(SEC) Trade
"List of trade and its description"/

ALIAS (SEC, SEC2), (A,AA), (C,CC), (I,II), (T,TT) ;
**DATA HANDLING**

This section imports the SAM data from the spreadsheet to GAMS. Notes on the function GDXXRW:

i) It converts the data from a spreadsheet file and transforms it into a *.gdx file readable in GAMS.

ii) The same function also makes a spreadsheet file from a GAMS file.

iii) Spreadsheets in the format *.xlsx are compatible with GAMS version after 22.6.

iv) The GDXXRX function is available to GAMS version after 21.0 (included).

PARAMETER SAM(SEC,SEC2)

\$call gdxxrw input="C:\GAMS\data.xls" output="C:\GAMS\data.gdx" par=SAM rng="sheetname!A1:O15" cdim=1 rdim=1

\$gdxin C:\GAMS\ data.gdx
\$load SAM
\$GDXIN

PARAMETER AND BENCHMARK VARIABLES DEFINITION

Note on CGE model:

i) BENCHMARK VARIABLES: data used to calibrate the base year variables and parameters.

ii) PARAMETERS: unchangeable variables such as elasticity, tax rate, etc.

iii) To avoid problem with base year variables the o after name is used. Ex: C(i,h) vs Co(i,h)

PARAMETER

Parameters from SAM
"List all the parameters and definition"
** Variables definition for the base year
"List variables for base year"
;

******** ASSIGNING DATA FROM SAM TO VARIABLES ********
****************************************************************
"Assign to the variables listed above the SAM value. This is done
by associating the variable with the correct SAM partition."

******** Calculation and calibration of variables ********
** Skipped in this document **
****************************************************************
****************************************************************
******** MODEL ********
****************************************************************

References
Maisonnave, H. and Robichaud, V. (2010) Training Session on CGE Model-
ing: Three Basic CGE Models. Available at http://www.pep-net.org/sites/pep-
net.org/files/typo3doc/pdf/volume2.pdf

Available at http://gams.com/mccarl/mccarlml/gams_user_guide_2005.htm

Robichaud, V. (2010) An introduction to GAMS. Available at:


Example


Figure 3: SAM on Spreadsheet

![Figure 3: SAM on Spreadsheet](image)

******************************************************************************
****** GAMS PROGRAM: CGE MODEL USING SPREADSHEET SAM ******
****** Some of the calculation and calibration as well as the CGE ******
****** model can be seen at Robichaud (2010) ******
******************************************************************************

******************************************************************************
****** DATA ******
******************************************************************************

******************************************************************************
****** SETS AND PARAMETERS ******
******************************************************************************

******************************************************************************
****** SETS DEFINITION ******
******************************************************************************

SET SEC All
/ LD, KD, HW, HC, F, AGR, IND, SER, ACC, TOT /
I(SEC) Sectors
/ AGR agriculture
   IND industry
   SER services /

GOOD(I) Goods
/ AGR agriculture
   IND industry /

H(SEC) Households
/ HW labour endowed households
   HC capital endowed households /

ALIAS (I,J), (SEC, SEC2), (H,HH)
;

************* DATA HANDLING *************

PARAMETER SAM(SEC,SEC2)

PARAMETER SAM(SEC,SEC2)
$call gdxxrw input=C:\GAMS\data.xls output=C:\GAMS\data.gdx
par=SAM  rng=data!A1:J11 cdim=1 rdim=1

$gdxin C:\GAMS\data.gdx
$load SAM
$GDXIN
;

************* PARAMETER AND BENCHMARK VARIABLES DEFINITION *************

PARAMETER
** Parameters from SAM
A(j) Scale coefficient (Cobb-Douglas production function)
aij(i,j) Input output coefficient
alpha(j) Share coefficient (Cobb-Douglas production function)
gamma(i,h) Share of the value of commodity i in total consumption
io(j) Coefficient (Leontief total intermediate consumption)
lambda Share of capital income received by capitalists
mu(i) Share of the value of commodity i in total investment
psi(h) Propensity to save for household h
v(j) Coefficient (Leontief value added)

** Variables definition for the base year
CO(i,h) Consumption of commodity i by type h households
CIO(j) Total intermediate consumption of industry j
DIO(i,j) Intermediate consumption of commodity i in industry j
DITO(i) Total intermediate demand for commodity i
DIVO Dividends
INVO(i) Final demand of commodity i for investment purposes
ITO Total investment
KDO(j) Sector j demand for capital
LDO(j) Industry j demand for labour
LSO Total labour supply
PO(i) Price of commodity i
PVAO(j) Value added price for industry j
RO(j) Rate of return to capital from industry j
SFO Firms’ savings
SHO(h) Savings of type h household
VAO(j) Value added of industry j
WO Wage rate
XSO(j) Output of activity j
YFO Firms’ income
YHO(h) Income of type h household

******** ASSIGNING DATA FROM SAM TO VARIABLES ********

CO(i,h) = SAM(i,h);
DIO(i,j) = SAM(i,j);
DIVO = SAM('HC','F');
INVO(i) = SAM(i,'ACC');
IT0 = SAM('TOT','ACC');
KDO(j) = SAM('KD',j);
lambda = SAM('HC','KD');
LDO(j) = SAM('LD',j);
SFO = SAM('ACC', 'F');
SHO(h) = SAM('ACC', h);
YFO = SAM('TOT','F');
XSO(j) = SAM('TOT',j);
YHO(h) = SAM('TOT',h);

********* Calculation and calibration of variables *********
******************************************************************
********* MODEL *********
******************************************************************