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Amir Borges Ferreira Neto  
West Virginia University, amneto@mix.wvu.edu

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## Using a Spreadsheet SAM for GAMS CGE Modeling

AMIR BORGES FERREIRA NETO

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# Using a Spreadsheet SAM for GAMS CGE Modeling\*

## **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

	Industries	Commodities	Factors	Institutions	Trade	Total
Industries		Make Matrix			Commodity Exports	Industry Output
Commodities	Use Matrix			Domestic Commodity Consumption		Domestic Commodity Output
Factors	Value Added					Value Added
Institutions		Domestic Commodity Sales	Factor Disbursements	Inter-Institutional Transfers	Commodity & Factor Services Exports	Institutional Receipts, Commodities, Factor
Trade	Commodity Imports		Factor Services Imports	Commodity Imports & Remittances	Trans-shipments	Services Imports, Remittances
Total	Industry Output	Domestic Commodity Output	Factor Outlay	Institutional Outlay	Commodity Factor Services Exports	

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 document 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;

Figure 2: Style 1 of organizing program in GAMS

<b>Data:</b>	Set declarations and definitions Parameter declarations and definitions Assignments Display
<b>Model:</b>	Variable declarations Equation declarations Equation definition Model Definition
<b>Solution:</b>	Solve Display

Source: Rosenthal (2014).

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 wont 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 transform it on a *.gdx **
** filereadable 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
\$_GDGIN
;

```

```

*****  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 Modeling: Three Basic CGE Models. Available at <http://www.pep-net.org/sites/pep-net.org/files/typo3doc/pdf/volume2.pdf>

McCarl, B. A. (2014) McCarl Expanded GAMS User Guide Version 24.1. Available at [http://gams.com/mccarl/mccarlhtml/gams\\_user\\_guide\\_2005.htm](http://gams.com/mccarl/mccarlhtml/gams_user_guide_2005.htm)

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## Example

Example based on Maisonnave and Robichaud (2010) and Robichaud (2010).  
Model of a closed economy without government.

Figure 3: SAM on Spreadsheet

	A	B	C	D	E	F	G	H	I	J
1		LD	KD	HW	HC	F	AGR	IND	SER	ACC
2	LD						5760	7560	15540	
3	KD						1440	11340	5720	
4	HW	28860								
5	HC		11100			1900				
6	F		7400							
7	AGR			4329	650		120	2526.9	275.5	1098.6
8	IND			11544	3900		1544	21709.1	5815.5	9887.4
9	SER			10101	5850		136	11264	3349	
10	ACC			2886	2600	5500				
11	TOT	28860	18500	28860	13000	7400	9000	54400	30700	10986

```

*****
***** 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 gdxrw 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');
ITO = 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 *****
*****
```