

Technical University of Denmark



## Teaching material for modelling course

CGE Malaysia model: Data construction, SAM and modelling exercises

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***Henrik Klinge Jacobsen, Henrik Meyer***

**Mission to Malaysia**

**Facilitation of 1 week CGE training, Penang**

**21. January – 26 January 2002**

## Scope of mission

The scope of the mission is to hand over the first raw version of the CGE energy sector model to the Macroeconomic working group members taking part in the training, through that process to train the participants in all major aspects of the model development, and to plan for the further development of the model. The two experts will divide the duties among themselves such as to optimise the effectiveness of the mission.

## Activities

Henrik Meyer and Henrik Jacobsen will focus on the following activities:

### *1. Presentation of the draft version of the CGE model*

HJ and HM will present their work on the CGE model in such a way that the four macroeconomy participants will be full overview of the model structure as well as the methodology applied. The presentation will be supported by an broad documentation of the structure, which will be forwarded by e-mail one before the presentation.

### *2. Training in specific aspects of the modelling*

During the presentation of the CGE model, the two experts will perform ad-hoc training in relevant issues pertaining to CGE modelling. The aim is that the participants in the WG will be able to proceed on their own on the model development for the next few months having only remote access to assistance from the Danish consultants via e-mail.

### *3. Facilitation of the preparation of the next few month's work in the MaWG (including the members not participating in the training).*

The consultants will facilitate a discussion of the types of findings and results, which the model should most importantly be able to provide. Based on this, the consultants will facilitate the planning of the future development of the model, including data collection efforts as well as suggested inputs from other working groups.

### *4. Assistance to the presentation of the present status of the model to the rest of the other working groups*

By the end of the week, the group will present the model as well as the findings of the above discussions. The consultants will facilitate this presentation.

### *5. Preparation of model documentation*

The model documentation will be an ongoing process throughout the rest of the project period. The consultants together with the participants will plan for the preparation of the documentation by defining a structure of the documentation and a distribution of tasks.

### *6. Reporting*

Upon termination of the mission the consultants will provide a short report of the proceedings of the mission, attached a documentation structure.

## Appendix A Exercise E: a simple model with calibration

In the exercise C energy was introduced as a factor input. Now we treat energy as a good produced in a sector and not as an initial endowment of consumers. However, the representation of energy as an input factor is kept in the input demand specification.

Consumers are just one group of households and the CD representation of utility is maintained.

Consider the SAM (social accounting matrix) where you have to fill out the data from the benchmark data entered into the GAMS code:

		<i>Budget constraints</i>						
		AGRI	MAN	SERV	GOVS	ENERGY	Househ	sum
Market clearing	AGRI							0
	MAN							0
	SERV							0
	GOVS							0
	ENERGY							0
	K							0
	L							0
Tax							0	
sum		0	0	0	0	0	0	0

The SAM needs to be balanced in the way that the sum of each row and column is zero, and so all markets clear, and all budgets balance.

The first parts of dealing with both producing sectors and commodities is reflected below in the program by having a two-dimensional set mapping from producing sectors to commodities. The set S2 gives the elements that are allowed to be different from zero. In the initial program only diagonal elements are different from zero. This is done by freeing the variable of the production YG but only for the diagonal elements S2. This facility should be used when enlarging the variables/matrices.

```

$$TITLE SIMPLE 5x5x1 MODEL WITH ENERGY AS A GOOD AND A
SECTOR
* based on TWP Example C/ HJ / 2001-07-27

SET
          G          Goods          /AGRI, MAN,
SERV, GOVS, ENERGY/
          S          Producing sectors /AGRI, MAN,
SERV, GOVS, ENERGY/
          S1(S,G) Goods to sector mapping /(AGRI,
MAN,SERV,GOVS, ENERGY).(AGRI, MAN,SERV,GOVS, ENERGY)/

```

```

                S2(S,G) Diagonal elements /AGRI.agri,
MAN.man,SERV.serv,GOVS.govs, ENERGY.energy/
                F      Factors /K, L, E/
                FE(F) Endowment factors /K, L/;

* DEFINE BENCHMARK DATA SET
*
TABLE BENFACDEM(S,F) Factors used by sector
                K      L      E
AGRI           19     10     1
MAN            20     17     3
SERV           9      20     1
GOVS           19     80     1
ENERGY         11     5      1

PARAMETERS BENDEM(G) Household demand by commodity
/ AGRI 30, MAN 40, SERV 30, GOVS 0,
ENERGY 10/;

PARAMETERS ENDOW(F) Household endowments of a
factor
/K 78, L 132, E 0/;

PARAMETERS BENPRDN(S) Production by sector
/AGRI 30, MAN 40, SERV 30, GOVS
100, ENERGY 17/
SIGMA(S) Substitution elasticity
between factor inputs
/AGRI 0.3, MAN 0.5, SERV 0.3,
GOVS 0.3, ENERGY 0.1/
GOVCON(G) Government consumption
/AGRI 0, MAN 0, SERV 0, GOVS
100, ENERGY 0/;
PARAMETERS
BETA(S,F) Parameter in production function
ALFA(G) Share parameter by household of a
good
BENINC Benchmark income by household
BENP_G(G) Benchmark good price
BENP_S(S) Benchmark sector output price
BENP_F(F) Benchmark factor price
SCALE(S) Scale-parameter in production
TRANSFER Transfers;

* CALIBRATION
*
* Set benchmark prices to unity (Harberger convention)
BENP_G(G) = 1;
BENP_S(S) = 1;
BENP_F(F) = 1;

```

```

TRANSFER = 0;

* Calculate benchmark income
BENINC = SUM(G, BENDEM(G)*BENP_G(G));

* Calculate share parameters
ALFA(G) = BENDEM(G)*BENP_G(G)/BENINC;

* Calculate distribution parameters
BETA(S,F) =
BENFACDEM(S,F)*BENP_F(F)/(BENPRDN(S)*BENP_S(S));

* Calculate scale-parameter in production
SCALE(S) = BENPRDN(S)/ PROD(F,
BENFACDEM(S,F)**BETA(S,F));

DISPLAY ALFA, BETA, BENINC, SCALE;

* DEFINE MODEL
*
VARIABLES      Demand(G)      "Consumer demand"
               Income         "Consumer income"
               FInput(S,F)    "Producer factor demand"
               IInput(G,S)    "Intermediate input
demand"
               Y(S,G)         "Output in sectors"
               P_S(S)         "Output-price for
sectors"
               P_G(G)         "Output-price for goods"
               P_F(F)         "Factor-price"
               Dummy ;

EQUATIONS      E_Dem(G)       "Consumers CD demand
function"
               M              "Consumers income"
               Input_e(S,F)   "Factor demand"
               Iinp(S,G)      "Intermediate demand"
               Y_Pris(S)      "CD-price index for
outputs"
               LV_factors(FE) "Equilibr. cond. factor
market"
               LV_goods(G)    "Equilibr. cond. goods
market"
               Object;

E_dem(G)..
      Demand(G) =E= (Alfa(G)*Income/P_G(G))+Govcon(G);

M..

```

```
Income =E= sum(f, p_f(f)*endow(f))+transfer-  
sum(g, Govcon(G));
```

```
Input_e(S,F)..
```

```
    Finput(S,F) =E= BETA(S,F)*Sum(G,  
Y(S,G))*P_S(S)/P_F(F);
```

```
Iinp(s,"Energy")..
```

```
    Iinput("energy",s) =E= Finput(S,"E");
```

```
Y_Pris(S)..
```

```
    P_S(S)*SCALE(S) =E= PROD(F,  
(P_F(F)/Beta(S,F))*Beta(S,F));
```

```
LV_factors(FE)..
```

```
    Sum(S, FInput(S,FE)) =E= endow(FE);
```

```
LV_goods(G)..
```

```
    sum(S$$s2(S,G),Y(S,G)) =E=  
Demand(G)+sum(s,Iinput(G,s));
```

```
Object..
```

```
    DUMMY =E= 1;
```

```
Model test /ALL/;
```

```
Demand.L(G) = 1; Demand.LO(G) =0.001;  
Demand.UP(G) =1000;  
P_S.L(S) = 1; P_S.LO(S) =0.001;  
P_S.UP(S) =1000;  
P_G.L(G) = 1; P_G.LO(G) =0.001;  
P_G.UP(G) =1000;  
P_F.L(F) = 1; P_F.LO(F) =0.001;  
P_F.UP(F) =1000;  
Income.L = 1; Income.LO =0.001;  
Income.UP =1000;  
FInput.L(S,F) = 1; FInput.LO(S,F) =0.001;  
FInput.UP(S,F) =1000;  
Y.L(S,G) = 1; Y.LO(S,G) =0.001;  
Y.UP(S,G) =1000;  
P_F.FX("L") = 1;  
Iinput.fx(G,S) = 0;  
IInput.L("Energy",S) = 1; IInput.LO("Energy",S)  
=0.001; IInput.UP("Energy",S) =1000;  
Y.fx(S,G) = 0;  
Y.L(S2(S,g)) = 1; Y.LO(S2(S,G))  
=0.001; Y.UP(S2(S,G)) =1000;
```

```

* SOLVE BENCHMARK CASE

SOLVE test USING NLP MAX dummy;
DISPLAY "Benchmark", Y.L, Demand.L, Income.L, P_G.L,
P_F.L, FInput.L, Y.L;

* Homogeneity test

* P_F.FX("L") = 1.5;
* SOLVE test USING NLP MAX dummy;
* DISPLAY "Is the model homogenous?", Y.L, Demand.L,
Income.L, P_G.L, P_F.L, FInput.L;

```

**3. Exercises:**

First run the model, and look at the calibrated parameters (for the utility and production functions) in the output. The production function (demand specification have also not been changed yet).

1. Write the SAM as reflected in the benchmark data
2. Does the model pass the replication check.
3. Complete the government sector by introducing endogenous income taxes that secure the collection of revenue for the exogenous variable government consumption (budget constraint)
4. Expand the model by splitting the energy sector in two sectors: electricity and extraction of oil and gas
5. Introduce two energy goods as produced by the two energy sectors
6. Introduce an additional energy good by splitting the good produced in the extraction sector into oil and natural gas (use the sector by goods set S2 to free the off diagonal elements)
7. Change implicit production function to a CES function and use the substitution elasticities (Sigma). Assume that all three inputs enter the production function at the same level (no nesting). Hereby substitution between all three inputs is similar and the  $\beta$ 's should be calibrated from the benchmark factor demands.

$$Y = F(K,L,E)$$

$$Y = A \left( \beta_K K^{\frac{\sigma-1}{\sigma}} + \beta_L L^{\frac{\sigma-1}{\sigma}} + \beta_E E^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1}{\sigma-1}}$$



## Appendix B: MEM data

### Description of main data sources

The traditional main source for macroeconomic data is the national department of statistical (DOS), Ministry of Finance (MOF) and Economic Planning Unit (EPU). Besides these sources the I/O table of 1995 in the Asian International Input-Output Project by the Institute of Developing Economies (Japan) is core source by constituting the I/O of the SAM. Additionally data from TNB on energy is used in relating energy consumption to income.

The financial crises in East Asia in 1998, also affecting Malaysia severely, is important with regard to statistical data. Generally considered data from 1998 and 1999 are considered to unrepresentative of the Malaysian economy.<sup>1</sup>

The base year of macroeconomic data is 1995. This is based on considerations on the I/O data 1995, together with generally unrepresentative data of 1998 and 1999, typically the latest available data at the outset of the project.

Data collection has been focussed on data for firstly a macro-SAM and secondly a micro-SAM for 1995.

### Documentation of macro-SAM

The construction of the macro-SAM follows Pyatt & Round (1985) and is basically as shown in Table 1.

Table 1 Macro-SAM outline.

Expenditures Receipts	Activities	Commodities	Factors	Households	Enterprises	Government	ROW	Savings-Investment	Total
Activities		marketed outputs		home consumed outputs					activity income
Commodities	intermediate inputs	transactions costs		private consumption		government consumption	exports	investment	demand
Factors	value-added						factor income from ROW		factor income
Households			factor income to households	inter-household transfer	surplus to households	transfers to households	transfer to households from ROW		household income
Enterprises			factor income to enterprises			transfers to enterprises	transfer to enterprises from ROW		enterprise income
Government	producers taxes, value-added tax	sales and export taxes, tariffs	factor income to gov't, factor taxes	transfer to gov't, direct household taxes	surplus gov't, direct enterprise taxes		transfer to government from ROW		government income
ROW		imports	factor income to ROW		surplus to ROW	government transfers to ROW			foreign exchange outflow
Savings-Investment				households savings	enterprise savings	government savings	foreign savings		savings
Total	activity expenditures	supply	factor expenditures	household expenditures	enterprise expenditures	government expenditures	foreign exchange inflow	investment	

Source: Löfgren et al. (2001).

For further presentation of the SAM approach and methodology see Jacobsen & Meyer (2001) or a full example in Nielsen (2001).

<sup>1</sup> The 8<sup>th</sup> Plan, p. 23 points to the contraction starting in 1998 and of the sharp economic recovery in 1999. National accounts supports this with GDP in billion RM, at constant 1987 prices being respectively: 197 (1997), 182 (1998) and 193 (1999). So recovery was almost complete in 1999, latest figures in GDP until 2001 (EPU, [www.epu.jpm.my/eif2000/1.html](http://www.epu.jpm.my/eif2000/1.html)) shows that earlier growth rates are re-established.

The main sources for the construction of the macro-SAM are:

Abbreviation	Publication
YB1998	Yearbook of Statistics Malaysia 1998, Department of Statistics, Sept 1998.
YB1999	Yearbook of Statistics Malaysia 1999, Department of Statistics, Sept 1999.
YB2000	Yearbook of Statistics Malaysia 2000, Department of Statistics, Sept 2000.
NA	Annual National Product and Expenditure Accounts 1987-2000, Department of Statistics, May 2001-08-02.
I/O	Asian International Input-Output Project: Institute of Developing Economies, Japan External Trade Organization, Japan March 2001.
MOF1999	Economic Report 1999/2000, Ministry of Finance 1999.
7 <sup>th</sup> Plan	Seventh Malaysia Plan 1996-2000, May 1996.
8 <sup>th</sup> Plan	Eight Malaysia Plan 2001-2005, April 2001.
MEF	The Malaysian Economy in Figures 2001, EPU.
NEB2000	MECM - Ministry of Energy, Communication and Multimedia (2000). National Energy Balance Malaysia (1980-1999 and Q3, Q4, 1999).
TNB	TNB Consumption and Production <sup>2</sup> datasheets.

Most of the data extraction is straight forward, while some are less obvious. Especially the I/O for 1995 covers all of Asia in principle, i.e., it is an I/O table where each countries sector and country enters. In this way the I/O table gets quite huge. Each country has 24 sectors, so with 12 countries (including Rest of the World) the I/O table consists of almost 300 columns and rows. In order have one common unit all local currency figures have been converted to USD. The average exchange rate for 1995 between RM (MYR) and USD is 2.51.<sup>3</sup>

Table 2 Macro-SAM specification.

Expenditures	Activities	Commodities	Factors	Households	Enterprises	Government	ROW	Capital Accounts	Total
Receipts	1	2	3	4	5	6	7	8	
Activities	1	marketed outputs		home consumed outputs					activity income
Commodities	2	intermediate inputs	transactions costs	private consumption		government consumption	exports	investment	demand
Factors	3	value-added					factor income from ROW		factor income
Households	4		factor income to households	inter-household transfer	surplus to households	transfers to households	transfer to households from ROW		household income
Enterprises	5		factor income to enterprises			transfers to enterprises	transfer to enterprises from ROW		enterprise income
Government	6	producers taxes, value-added tax	sales and export taxes, tariffs	factor income to gov't, factor taxes	transfer to gov't, direct household taxes	surplus gov't, direct enterprise taxes	transfer to government from ROW		government income
ROW	7		imports	factor income to ROW		surplus to ROW	government transfers to ROW		foreign exchange outflow
Capital Accounts	8			households savings	enterprise savings	government savings	foreign savings		savings
Total		activity expenditures	supply	factor expenditures	household expenditures	enterprise expenditures	government expenditures	foreign exchange inflow	investment

All greyed cells represent potential data that is *not* included in the Malaysian SAM either because the data is consider less important and/or data is difficult to obtain.

### Documentation of the entities in the macro-SAM<sup>4</sup>

Row 1: Activities
-------------------

<sup>2</sup> To be included in MEDIS.

<sup>3</sup> \*\*\* Awaiting info from Lim\*\*\*.

<sup>4</sup> References to cells are always done by (row,column).

(1,2 )	Marketed outputs	I/O. Production
(1,4 )	Home consumed outputs	... No data source found. This entity is likely to most important for the agricultural sector and almost ignorable for other sectors. Since the model does not consider rural households separately the data has not been entered.
	<b>Row 2: Commodities</b>	
(2,1 )	Intermediate inputs	I/O. Intermediate inputs domestic + imported (ET×AM900)
(2,2 )	Transactions costs	...
(2,4 )	Private consumption	
(2,6 )	Government consumption	
(2,7 )	Exports	
(2,8 )	Investment demand	
	<b>Row 3: Factors</b>	
(3,1 )	Value-added	I/O. Total factor inputs (GDP at factor prices)
(3,7 )	Factor income from ROW	... This is mainly wage income from abroad as retained earnings and dividends. It is assumed that it for the larger part is received by enterprises.
	<b>Households</b>	
(4,3 )	Factor income to households	Average household income × Number households (YB1998, p. 225 × <span style="background-color: #90EE90;">***</span> <sup>5</sup> , i.e., 2,007 × 12 RM year × HS = 103,267 million RM, implying that HS = 4,29) <sup>6</sup> .
(4,4 )	Inter-household transfer	... Marginal in a fairly developed economy.
(4,5 )	Surplus to households	... No source. <sup>7</sup>
(4,6 )	Transfers to households	<i>Pensions and gratuities</i> (YB1998, table 12.2). Note that no other accounts has been assessed as true transfers.
(4,7 )	Transfer to households from ROW	... No sources, probably small.
	<b>Enterprises</b>	

<sup>5</sup> Lim to get number of households.

<sup>6</sup> At present household size: 4,29.

<sup>7</sup> Lim might have some sources.

(5,3 )	Factor income to enterprises	Capital factor income (residual relative to household income) accurate data still missing.
(5,6 )	Transfers to enterprises	<i>Debt service charges</i> (YB1998, table 12.2), referred entirely to enterprises: financial institutions.
(5,7 )	Transfer to enterprises from ROW	Foreign direct investments is entered in (8,7) <i>Foreign savings</i> and not as transfers to enterprises.
	Government	
(6,1 )	Producers taxes, value-added tax	... No real producer taxes have been found, although there are several import and commodity duties. Only the petroleum tax could be considered as a production tax, but is included as part of government tax on factors, (6,3) <i>Factor income to gov't, factor taxes</i> . Whether it is included in one or the other is open for discussion.
(6,2 )	Sales and export taxes, tariffs	A. <i>Total indirect taxes</i> (YB1998, table 12.1).
(6,3 )	Factor income to government, factor taxes	C. <i>Total non-tax revenue</i> (YB1998, table 12.1).
(6,4 )	Transfer to government, direct household taxes	A. <i>Total indirect taxes, Individuals</i> (YB1998, table 12.1).
(6,5 )	Surplus government, direct enterprise taxes	A. <i>Total indirect taxes, Companies + Others</i> (YB1998, table 12.1).
(6,7 )	Transfer to government from ROW	Official long term capital balance (Balance of payments) BNM VIII.1 ***.
	ROW	
(7,2 )	Imports	
(7,3 )	Factor income to ROW	... Figures for wages to foreign labourers in Malaysia should be included here. Note that <i>Factor payments to enterprises</i> is treated as residual, since no source is available Might BNM have some figures? It is important to obtain some figure since the number of foreign workers is significantly. The number of non-citizens is 1.313 million in 1995 (YB1998, p. 35, table 3.7) or more the 10%. <sup>8</sup>

<sup>8</sup> The data are (YB1998 & YB2000, p. 35):

	1994	1995	1996	1997	1998	1999	2000
Non-citizen	1,160	1,313	1,389	1,469	1,554	1,645	1,741
Mal	698	794	850	900	953	1.010	1.057
e							
Fe	462	519	539	569	601	635	684
male							

(7,5 )	Surplus to ROW	
(7,6 )	Government transfers to ROW	... Ignorable in the case of developing countries (including Malaysia).
	Capital Accounts	
(8,4 )	Households savings	
(8,5 )	Enterprise savings	<sup>9</sup>
(8,6 )	Government savings	
(8,7 )	Foreign savings	

### Documentation of micro SAM

Sectoral disaggregation	I/O 1995 table
Factors (missing in I/O)	Manufacturing survey
Energy	DOS data from 1995. Lack of natural gas from these data. MIDA 1998 (70%, 30% firms)
Electricity consumption in household linked to income	TNB
Household expenditure survey	For income-consumption-energy information, assessed less important in this study and not included. Available from 1998/99 and 1993/94 (only on CD, 150.00 RM). Do <i>not</i> have a detailed listing of electricity, gas and other fuels on income groups Poverty definition <sup>10</sup>

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It is interesting that the number is apparently hardly affected by the East Asian financial crises in 1998. There is also a fairly high degree (40%) of female foreign in Malaysia.

<sup>9</sup> Present data is from 1996, needs to be corrected to 1995, probably based on MOF1998 which is presently unavailable.

<sup>10</sup> The poverty definition is relevant in relation to household if these are disaggregated. In the MEEM the intention is to make three groups, low (including poor), medium and high income. The definition of poverty in Malaysia based in 1995 can be found in the 7<sup>th</sup> Plan, p. 72, table 3-1 with three different limits for peninsular Malaysia (425 RM per month, average household size 4.6), Sabah (601 RM per month, average household size 4.9) and Sarawak (516 RM per month, average household size 4.8). Given the number of people in the three regions the average Malaysian limit is 450 RM per month and 4.6 as average household size (given just around 80% live on the peninsula). The so-called *hardcore* poverty level is estimated to be half of the above. The number of poor households amount to 9.6% and hardcore poverty is 2.2%, all in 1995 and including non-citizen. The trend is that poverty, as defined in the 7<sup>th</sup> Plan, is going to be very limited in the future.

Needed extracts from I/O to micro-SAM (Suhaimi): extract from the Japanese IO tables also the final demand components private consumption, government consumption, fixed capital formation (investments) and exports. This have to be done both with the demand for domestically produced goods (AM supplies to final demand categories) and for the import this have to be the sum of imports for the 24 sector goods and as the sum of imports from different countries and regions. Just take the imports for use in final Malaysian demand categories.

## **Documentation of energy data and enlargement of SAM with energy data**

### **Enterprises energy consumption**

Enterprises consume about 60% of total energy, including agriculture.

### **Households energy consumption**

First of all it should be noted that households energy consumption only constitutes a small share, about 5%, of total energy demand. Total *Residential and Commercial* final energy use in 1995 is about 13% of total energy use (NEB2000, p. 29). Data on the residential sub-sector (equal for households) is not available for 1995. However, for 1999, TNB (table 2.0) has data for residential sector alone (not including fuel for transport). Based on the 1999 data residential consumes approximately 35% of the *Residential and Commercial* sector. Transferring this information to 1995 indicates that household use around 1,000 ktoe or only 5% of total energy use.

The main data sources for linking energy consumption to income are HES; the two most recent surveys are from 1993/94 and 1998/99.

### **Other energy consumption**

Based on NEB2000 the remaining energy consumption is for transport, constituting around 35% in 1995.

### **Sources**

Institute of Developing Economies – IDE (2001). Asian International Input-Output Table 1995. Asian International Input-Output Project. Japan External Trade Organisation. IDE Statistical Data Series no. 82.

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