



## ANARRES\_3: A User Guide

Scott McDonald

Addresses for correspondence:

Scott McDonald,  
cgemod,  
14 Moncrieffe Road,  
Sheffield,  
S7 1HR, UK.  
Email: [scott@cgemod.org.uk](mailto:scott@cgemod.org.uk)  
Tel: +44 789 979 3671

### Abstract

This is a user's guide to the Globe CGE model. It is assumed that the user is familiar with the structure of the model database, the behavioural relationships in the model and CGE models implemented using the GAMS programming language. The User Guide refers to an implementation of the model that uses GAMSIDE as the text editor, GDX as the source of transactions data and destination of the model results, and MS Excel – in conjunction with GDXXRW - as the source data relating to sets and various exogenous parameters. It is assumed that the user will convert the GTAP database to a SAM format using the 'GTAP in a SAM' programmes, compile database aggregations using SAMGator and access the model results using GDX and/or SeeResults. This User Guide also not provide any guidance on how to frame policy experiments using (global) CGE models.

**THIS IS AN INCOMPLETE DRAFT THAT IS UNDERGOING CONTINUOUS DEVELOPMENT. IT IS PROVIDED ON THAT BASIS. COMMENTS ON THE CURRENT CONTENT ARE WELCOME.**

## Table of Contents

ANARRES: A User Guide.....	1
Table of Contents .....	2
1. Introduction.....	4
2. GTAP in a SAM.....	5
3. Aggregating the GTAP SAMs .....	14
4. GAMS Data Exchange (GDX) Database.....	23
5. Structure of the ANARRES Model Code .....	24
6. Model Data and Conditioning File .....	27
7. Compiling the Model's Excel Workbook.....	30
8. Model Calibration Checks .....	50
9. Developing 'Meaningful' Global CGE Experiments .....	51
10. Experiment File Template.....	55
11. Compiling an Experiment Excel Workbook.....	57
12. Market Clearing and Model Closure Rules .....	62
13. Tax Rate Shocks .....	68
14. Technology Shocks.....	69
15. Analysis File.....	70
16. Changing the Model Database.....	72
17. Fault Finding.....	73
References.....	74

# “DON'T PANIC”

CGE models, and especially global CGE models, can appear ‘insanely complicated’<sup>1</sup>. When things do not operate correctly it is tempting to ‘panic’; if you do you will be lost.

The reason(s) the model is not behaving is (usually) your fault: ask the right questions and you can make it behave. The most common causes for misbehaviour by the model are

1. typographical errors by the user;
2. errors in the data supplied to the model;
3. errors in model calibration;
4. unbalanced model – differences in the number of equations and variables;
5. errors in the equations;
6. inappropriate model closure settings; and
7. solver constraints.

The section on Fault Finding (16) provides advice on resolving these types of problem.

The most common causes of errors when developing experiment files are

1. typographical errors by the user;
2. errors in the experiment data;
3. errors in experiment calibration;
4. inappropriate in the closure settings; and
5. solver constraints.

These errors are addressed in various sections of this User Guide.

Above, all look after your towel.<sup>2</sup>

<sup>1</sup> ‘Don't Panic’ is a phrase on the cover of The Hitchhiker's Guide to the Galaxy. .... [partly because] the device "looked insanely complicated" to operate, and partly to keep intergalactic travellers from panicking. "It is said that despite its many glaring (and occasionally fatal) inaccuracies, the Hitchhiker's Guide to the Galaxy itself has outsold the Encyclopedia Galactica because it is slightly cheaper, and because it has the words 'DON'T PANIC' in large, friendly letters on the cover."

<sup>2</sup> ... a towel has immense psychological value. .... if a strag (strag: non hitchhiker) discovers that a hitchhiker has his towel with him, he will automatically assume that he is also in possession of a toothbrush, washcloth, soap, tin of biscuits, flask, compass, map, ball of string, gnat spray, wet-weather gear, space suit etc., etc. .... What the strag will think is that any man who can hitch the length and breadth of the galaxy, rough it, slum it, struggle against terrible odds, win through, and still knows where his towel is, is clearly a man to be reckoned with. (Hitchhiker's Guide to the Galaxy)

## 1. Introduction

This User Guide is intended to support use of the ANARRES model. It is not an objective of this guide to provide technical information about the ANARRES model, nor is it an objective to provide introductions to the principles of CGE modelling or the mechanics of the General Algebraic Modelling System (GAMS). The guide provides information about the structure of the model and experiment programmes, the data, aggregating the global SAM, setting up and configuring the model, setting up and configuring an experiment file, arranging data for the model and experiments and guidance when fault finding.

The User Guide assumes that a new user has access to a working version of the ANARRES model: by this it is meant that the starting point is a model that contains a ‘correct’ database – balanced SAM and coherent exogenous data, e.g., elasticities, is correctly calibrated with an equal number of variables and equations, a consistent set of behavioural equations and model closure settings. It is also assumed that the model is not subject to solver constraints.

These assumptions mean that the majority of this User Guide is devoted to the implementation of experiments rather than the implementation of the model using a different database, i.e., the target audience is users of the model not modellers, and participants on *cgemod*<sup>3</sup> courses.

The rest of this Guide is organised as follows. The next three sections consider the SAM representation of the GTAP database, aggregating the database and presenting the database using GAMS Data EXchange (GDX). The structure of the model code is reviewed in section 5, which is followed by two sections about additional data required for the model. Means of checking the model is correctly calibrated are reviewed in section 8. The next four sections concentrate on developing appropriate experiments, the template experiment file, its associated Excel data file, and the setting of the model’s closure conditions. Sections 13 and 14 illustrate shocks using tax and technology experiment with section 15 given over to the analyses of results. Sections 16 and 17 concentrate on changing the database and fault finding.

---

<sup>3</sup> See [www.cgemod.org.uk/training.html](http://www.cgemod.org.uk/training.html)

## 2. GTAP in a SAM

The GTAP database represents a major resource for economists who engage in multi-sector global modelling. The database is supplied in the Header Array (HAR) file format, which is used by GEMPACK, RunGTAP and associated software developed for/by the GTAP project. However, while the HAR file format is very efficient it is not immediately usable by modelling programmes written using different software, e.g., GAMS, and although some modellers may wish to use the GTAP data, they may not wish to use the GTAP model and/or GEMPACK. One alternative is the GTAP in GAMS suite developed by Rutherford (1998), which provides both a means of transferring the data into a GAMS readable format and a representation of the GTAP model in GAMS. But while it is possible to use the programmes associated with GTAP in GAMS, in particular SEEHAR and HAR2GAMS, to transfer GTAP data into a GAMS readable format there may be occasions when modellers wish to transform the GTAP database.

One potential transformation of the GTAP database is its conversion from a format based on a form of input-output table with additional sub matrices for trade and other transactions that are presented as a series of multi-dimensional sub matrices into a single three dimensional Social Accounting Matrix (SAM) format. Since the databases for ALL whole economy models can always be represented in a SAM format, and some modellers choose to present their model databases in SAM format, such a transformation has attractions. The three most obvious attractions are:

- i) the increased use by economists of the SAM format, especially now that it is formally part of the System of National Accounts (SNA) (UN, 1993);
- ii) the greater ease with which the data for a single region can be assessed and related to national account aggregates; and
- iii) the arguably greater accessibility of the information for policy makers.

The transformation of the database to a SAM format does however involve some complications. These arise, for the most part, from the fact that the GTAP database does not appear, at first sight, to observe the 'law of one price' in the rows of the input-output tables, i.e., the purchaser prices are not common across the rows of the input-output tables, due to the tax specification in GTAP.

One approach to overcoming the complications presented by the apparent absence of the ‘law of one price’ is to value entries in the commodity rows of the SAM at ‘sellers’ prices, thereby ensuring that all the entries in each commodity account row are valued at a common price. The purchasing agents are then assumed to make a separate payment to the government with respect to indirect taxes on commodities purchased for consumption/demand by domestic agents. This approach ensures that the national accounting identities for the SAM are maintained. This method will transform the GTAP database into a global SAM format that is FULLY consistent with the structure of the price and tax systems found in the GTAP model: it was adopted by McDonald and Thierfelder (2004), and has since the release of GTAP version 7.1 been a standard component within the GTAPAgg programme used to distribute the GTAP database.

The GTAP in a SAM database is the basis for the data used by the GLOBE model. A detailed description is provided in McDonald and Thierfelder (2004, 2019).

## 2.1 Reduced Form GTAP SAMs

However, the ANARRES CGE model is not set up to deal with domestic commodity demands that are valued at ‘sellers’ prices. Consequently, using the database to calibrate the GLOBE model requires transforming the GTAP SAM so that domestic demands are recorded in purchaser prices. This transformation depends upon the treatment of indirect/sales taxes on commodities purchased for consumption/demand by domestic agents; this and several other transformations are discussed in McDonald (2007). Some other developments of the database that may enrich the representation of global economic transactions captured by the GTAP database are reported in McDonald and Sonmez (2004).

### *2.1.1 A GTAP SAM for GLOBE*

The structure of the GLOBE SAM is illustrated by means of a representative SAM for one region – the structure of the SAM for every region is identical. The description of the SAM structure is limited, since it is assumed that the reader is familiar with the basic principles of a SAM (see King, 1985; Sadoulet and de Janvry, 1995; Pyatt and Round, 1977; Pyatt, 1991; and Reinert and Roland-Holst, 1997). In general terms the SAM structure follows the conventions of the System of National Accounts for 1993 (UN, 1993), with adjustments considering the limited data on intra-institutional accounts. The basic structure is identified in

Table 1, wherein the transactions captured by each of the active sub matrices of the SAM are defined/described.

### 2.1.2 ANARRES Social Accounting Matrix

The ANARRES SAM can be conceived of as a series of single region SAMs that are linked through the trade accounts; it is particularly valid in the context of the GTAP database to note that the ONLY way in which the regions are linked directly in the database is through commodity trade transactions and trade ‘balances’ although there are some indirect links through the demand for and supply of trade and transport services. Specifically the value of exports, valued free on board (*fob*), from source  $x$  to destination  $y$  must be exactly equal to the value of imports valued *fob* to destination  $y$  from source  $x$ , and since this holds for all commodity trade transactions the sum of the differences in the values of imports and exports by each region must equal zero. However, the resultant trade ‘balances’ do not fully accord with national accounting conventions because other inter regional transactions are not recorded in the database (see McDonald and Sonmez, 2004). A description of the transactions recorded in a representative SAM for a typical region in the database is provided in Table 1.

DRAFT

**Table 2.1 Social Accounting Matrix for a Region in the Global Social Accounting Matrix**

	Commodities	Activities	Factors	Households	Government	Capital	Margins	Rest of World	Totals
<b>Commodities</b>	0	Combined Intermediate Use Matrix	0	Private Consumption	Government Consumption	Investment Consumption	Exports of Margins (fob)	Exports of Commodities (fob)	Total Demand for Commodities
<b>Activities</b>	Domestic Supply Matrix	0	0	0	0	0	0	0	Total Domestic Supply by Activity
<b>Factors</b>	0	Expenditure on Primary Inputs	0	0	0	0	0	0	Total Factor Income
<b>Households</b>	0	0	Distribution of Factor Incomes	0	0	0	0	0	Total Household Income
<b>Government</b>	Taxes on Commodities	Taxes on Production Taxes on Factor Use	Direct/Income Taxes	Direct/Income Taxes	0	0	0	0	Total Government Income
<b>Capital</b>	0	0	Depreciation Allowances	Household Savings	Government Savings	0	Balance on Margins Trade	Foreign Savings	Total Savings
<b>Margins</b>	Imports of Trade and Transport Margins	0	0	0	0	0	0	0	Total Income from Margin Imports
<b>Rest of World</b>	Imports of Commodities (fob)	0	0	0	0	0	0	0	Total Income from Imports
<b>Totals</b>	Total Supply of Commodities	Total Expenditure on Inputs by Activities	Total Factor Expenditure	Total Household Expenditure	Total Government Expenditure	Total Investment	Total Expenditure on Margin Exports	Total Expenditure on Exports	

A SAM is a transactions matrix; hence each cell in a SAM simply records the values of the transactions between the two agents identified by the row and column accounts. The selling agents are identified by the rows, i.e., the row entries record the incomes received by the identified agent, while the purchasing agents are identified by the columns, i.e., the column entries record the expenditures made by agents. As such a SAM is a relatively compact form of double entry bookkeeping that is complete and consistent and can be used to present the National Accounts of a country in a single two-dimensional matrix (see UN, 1993, for a detailed explanation of the relationship between conventional and SAM presentations of National Accounts). A SAM is *complete* in the sense that the SAM should record ALL the transactions within the production boundary of the National Accounts, and *consistent* in the sense that income transactions by each and every agent are exactly matched by expenditure transactions of other agents. A fundamental consequence of these conditions is that the row and column totals of the SAM for each region must be identical, and hence the SAM provides a complete characterisation of current account transactions of an economy as a circular (flow) system. In the context of a global SAM the *complete* and *consistent* conditions need extending to encompass transactions between regions; this simply requires that each and every import transaction by a region must have an identical counterpart export transaction by another region. This is enough to ensure that the resultant global SAM provides a characterisation of current account transactions of the global economy as a circular (flow) system.

Given these definitions of a SAM the transactions recorded in a SAM are easily interpreted. In Table 1 the row entries for the commodity accounts are the values of commodity sales to the agents identified in the columns, i.e., intermediate inputs are purchased by activities (industries etc.), final (consumption) demand is provided by households, the government and investment demand and export demand is provided by the all the other regions in the global SAM and the export of margin services. The commodity column entries deal with the supply side, i.e., they identify the accounts from which commodities are purchased so to satisfy demand. Specifically, commodities can be purchased from either domestic activities – the domestic supply matrix valued inclusive of domestic trade and transport margins – or they can be imported – valued exclusive of international trade and transport margins. In addition to payments to the producing agents – domestic or foreign – the commodity accounts need to make expenditures with respect to the trade and transport services needed to import the commodities and any commodity specific taxes.

The GTAP database provides complete coverage of bi lateral transactions in commodities – these are valued free on board (*fob*) - but only provides partial coverage of transactions in trade and transport margins. Specifically the imports of trade and transport margins by each region are directly associated with the imports of specific commodities, hence for each commodity import valued *fob* the source and destination regions are identified and the value of each trade and transport margin service used is identified. The sum of the values of trade and transport services and the *fob* value of the commodity imports represent the carriage insurance and freight (*cif*) paid value of each imported commodity. But the source regions of the trade and transport services are NOT identified, and similarly the values of exports of trade and transport services by a region do NOT identify the destination regions. To overcome this lack of information an artificial region called Globe is included in the database. This region collects together all the exports of trade and transport services by other regions as its imports and then exports these to other regions to satisfy their demand for the use of trade and transport services associated with commodity imports. By construction the value of imports by Globe for each and every trade and transport margin service must exactly equal the value of exports for the corresponding trade and transport service. However this does not mean that the trade balance between Globe and each and every region must exactly balance, rather it requires that the sum of Globe's trade balances with other regions is exactly equal to zero.

An important feature of the construction of a SAM can be deduced from the nature of the entries in the commodity account columns. By definition the column and row totals must equate, and these transaction totals can be expressed as an implicit price times a quantity, and the quantity of a commodity supplied must be identical to the quantity of a commodity demanded. The column entries represent the expenditures incurred in order to supply a commodity to the economy and hence the implicit price must be exactly equal to the average cost incurred to supply a commodity. Moreover since the row and column totals equate and the quantity represented by each corresponding entry must be same for the row and column total the implicit price for the row total must be identical to average cost incurred to supply the commodity. Hence the column entries identify the components that enter the formation of the implicit prices in the rows, and therefore identify the price formation process for each price in the system. Typically, a SAM is defined such that the commodities in the rows are homogenous and that all agents purchase a commodity at the same price.

Total income to the activity accounts is identified by the row entries. In the simple representation of production in the GTAP database each activity makes a single commodity, and each commodity is made by a single activity, which means that the domestic SUPPLY matrix is a diagonal (square) matrix. The expenditures on inputs used in production are recorded in the activity columns. Activities use intermediate inputs, which in this version of the database are recorded as composites of domestically produced and imported commodities, primary inputs and pay taxes on production and factor use. For each region the sum of the payments to primary inputs and on production and factor use taxes by activity is equal to the activity's contribution to the value added definition of GDP while the sum over activities equals the region's value added measure of GDP.

The remaining accounts relate to the institutions in the SAM. All factor incomes are distributed to the single private household after making allowance for depreciation of physical capital and the payment of direct (income) taxes on factor incomes. Incomes from factor sales are also the sole source of income to the household account. Three categories of expenditures by the household account are recorded: direct (income) taxes, savings and consumption. The government receives incomes from commodity taxes, production taxes and direct taxes on factor and household incomes and uses that income to pay for consumption and for savings. In the basic form of the database government savings are set to zero for all regions; this stems from the reduced form representation of intra institutional transactions provided by the GTAP database (see McDonald and Thierfelder, 2004b).<sup>4</sup> There are therefore five sources of savings in each region: depreciation, household/private savings, government savings, balances on trade in margin services and balances on trade in commodities, but only a single expenditure activity – investment (commodity) demand.

As should be apparent from the description of the SAM for a representative region the database is strong on inter regional transactions but relatively parsimonious on intra-regional transactions.

### 2.1.3 Other GTAP Data

In addition to the transactions data the GTAP database contains other data that can be used with this model, and/or variants of the model. The most obviously useful data are the import

---

<sup>4</sup> McDonald and Sonmez (2004) demonstrate that it is straightforward to overcome this limitation of the database. The model described in this paper operates whether the government savings are zero or non-zero.

and primary factor elasticity data used in the GTAP model; the programme used to derive an aggregation of the SAM also contains a routine for aggregating these elasticities for use in this model. However, the GTAP elasticities are only a subset of the elasticities used in this model and it is therefore necessary to provide other elasticities even when using the GTAP elasticity data.

Other data of interest to modellers include estimates of energy usage and emissions, land use and migration. None of these data are used in this variant of the model, but there are variants.

#### *2.1.4 Database Dimensions*

The dimensions of the SAM are determined by the numbers of accounts within each aggregate group identified in Table 2.1, while the actual numbers of accounts in each group of accounts are defined for version 5.4, 6.0, 7.1, and 8 of the GTAP database in Table 2.2. Given the large number of accounts in the SAMs for each region and the relatively large number of regions the total number of cells in the global SAM is very large, although only slightly over 10 percent of the cells actually contain non zero entries; nevertheless this still means that the GTAP database contains more than 4 million transaction values, which implies that there are some 8 million possible prices and quantities that can be deduced from the database. Even allowing for the implications of adopting the law of one price for transactions in the rows of each region's SAM and for other ways of reducing the numbers of independent prices and quantities that need to be estimated in a modelling environment, it is clear that the use of the GTAP database without aggregation is likely to generate extremely large models (in terms of the number of equations/variables). Consequently, except in exceptional circumstances all CGE models that use the GTAP data operate with aggregations of the database.

**Table 2.2** Dimensions of the Global Social Accounting Matrix

Account Groups	Sets	Total Number of Accounts			
		GTAP 5.4	GTAP 6.0	GTAP 7.1	GTAP 8
Commodities	$C$	57	57	57	57
Activities	$A$	57	57	57	57
Factors	$F$	5	5	5	5
Taxes	$(2*r)+(1*f)+4$	165	183	233	267
Other Domestic Institutions	3	3	3	3	3
Margins	$3*r$	234	261	336	387
Trade	$R$	78	87	112	129
	<b>Total</b>	598	652	802	905
<b>Total Number of Cells in the Global SAM</b>		27,893,112	36,984,048	72,038,848	105,654,225

DRAFT

### 3. Aggregating the GTAP SAMs

The dimensions of the GTAP database require that for practical purposes the database must be aggregated before being used to calibrate a global CGE model. There are two main reasons for this:

1. If the database is not aggregated the resultant model would be too large to
  - a. solve within realistic limits of computer capacity, OR
  - b. yield results that would be susceptible to practical analyses and interpretation.
2. It is argued that models should be focused upon specific issues rather than being general and that part of the process of focus depends upon the identification of an appropriate aggregation for the purposes at hand.

An aggregation of the ANARRES SAM requires that the database is (simultaneously) aggregated in three dimensions, i.e., the intra-regional accounts for all regions are aggregated to reduce the number commodities/activities, factors, trade partners and associated transaction, and inter regional transactions are aggregated so as to accord with the aggregation of the trade accounts for each region. GAMS is an extremely efficient medium for implementing the calculations required to aggregate the ANARRES SAM,<sup>5</sup> but setting up the sets and (set) mappings to control the aggregation is potentially time consuming. One method for reducing the time costs involved in setting up a new aggregation, and simultaneously reducing the time required to configure the sets and other data needed to implement a version<sup>6</sup> of GLOBE with a new aggregation, is to use the SAMgator software (PROVIDE, 2004).

SAMgator is a Visual Basic for Applications (VBA) programme implemented using Microsoft (MS) Excel. The user declares, describes, and defines the new (aggregated) sectors (commodities and activities), factors and regions in an Excel template, identifies the source

---

<sup>5</sup> If the programme is run without the elements that provide weighted aggregates of the GTAP elasticities it runs very quickly, however the elements that aggregate the elasticities slows the programme down appreciably.

<sup>6</sup> The term “version of GLOBE” is used to refer to an implementation of the GLOBE model with a specific aggregation of the database. A “version of GLOBE” is used to refer to an implementation of a version of the GLOBE model that contains either ‘limited’ or no variations in the behavioural relationships of the GLOBE model. More substantial changes in the GLOBE model are identified by ‘extending’ the GLOBE name, e.g., GLOBE-IC (McDonald, 2007b) is a version of GLOBE with imperfect competition and GLOBE-EN (McDonald and Thierfelder, 2007c) is a version of GLOBE to model energy use.

and destination data files and then runs GAMS remotely from within the Excel programme<sup>7</sup>. The SAMgator programme generates the set and mapping files, checks to ensure that all the mappings are ‘legal’ and then generates the GAMS programme file.

Moreover, the same mapping sets can be used to aggregate other components of the GTAP database so that they are consistent with the transactions (SAM) data, e.g., the elasticities that are part of the GTAP database.

### 3.1 The Mechanics of SAMgator

At the heart of SAMgator is a single (GAMS) equation that aggregates the GTAP database in three dimensions (see below).

$$\begin{aligned} \text{NEWSAM}(sp, spp, k) &= \text{SUM}((ss, ssp, kk) \\ &\quad \$(\text{MAPSAMAG}(sp, ss) \\ &\quad \$\text{MAPSAMAG}(spp, ssp) \\ &\quad \$\text{MAPREGAG}(k, kk)), \\ &\quad \text{SAMG}(ss, ssp, kk)) ; \end{aligned}$$

The parameter  $\text{SAMG}(ss, ssp, kk)$  contains the GTAP database where  $ss$ <sup>8</sup> is the set that defines the row and columns labels for the SAM for each of the  $kk$  regions. The parameter  $\text{NEWSAM}(sp, spp, k)$  contains the GTAP database where  $s$  is the set that defines the row and columns labels for the aggregated (NEW)SAM for each of the  $k$  regions. The set  $\text{MAPSAMAG}(sp, ss)$  defines the members of  $ss$  that aggregated into  $sp$  by the rows of  $\text{SAMG}(ss, ssp, kk)$ , while the set  $\text{MAPSAMAG}(spp, ssp)$  defines the members of  $ssp$  that aggregated into  $ssp$  by the columns of  $\text{SAMG}(ss, ssp, kk)$ . (Note that there is only one mapping set  $\text{MAPSAMAG}$  with its implementation being solely driven by the sets  $ss$  and  $s$  and their aliases.) The set  $\text{MAPREGAG}(k, kk)$  defines the aggregation of regions  $kk$  into  $k$  for the aggregated (NEW)SAM for each of the  $k$  regions.

### 3.1 Using SAMgator

The user interface to SAMgator consists of three worksheets ‘Control’, ‘MappingConfig’ and ‘Sets’. A user only needs to access these three worksheets; although more experienced users may wish to use other features of SAMgator the discussion here is limited to these three worksheets.

<sup>7</sup> The GAMS code at the heart of SAMgator is report in the Appendices.

<sup>8</sup> The set  $ssp$  is an alias for  $ss$ .

### 3.1.1 Control

The 'Control' worksheet is used to identify the location of GAMS.EXE, input and output file names, check for errors, write output and to run the aggregation programme. A screen shot of the worksheet is given in Figure 3.1.1.1.

In order to run GAMS from within MS Excel it is necessary for Excel to know the location of the GAMS.EXE file; this information is provided in the 'GAMS.EXE location' box.<sup>9</sup> In order to test that Excel can implement a GAMS programme first click on the 'Pause after execution' box – so it has a tick in the box as in Figure 3.1.1.1 – and then click on the 'Test GAMS' button. A DOS window will appear (Figure 3.1.1.2); if this indicates a normal completion this is confirmation that Excel can trigger GAMS correctly and the user can press any key to continue.

---

<sup>9</sup> With some versions of GAMS spaces in the paths can lead to problems. Note how the screen shot indicates that GAMS.exe is stored in a GAMS directory on the C drive and not in the 'Program Files' directory that is the default destination when installing GAMS.

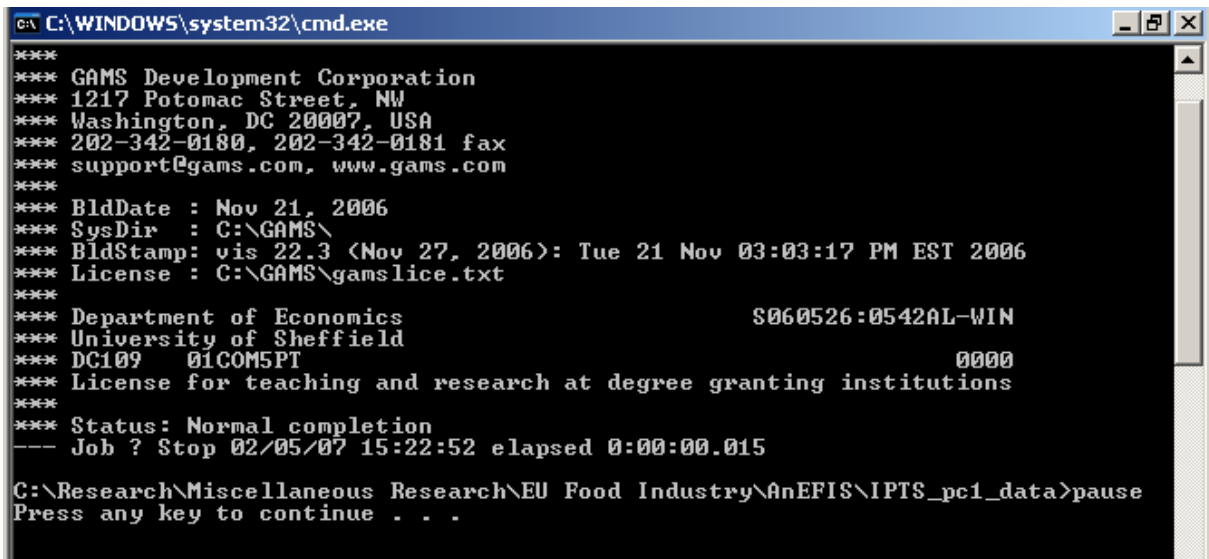
**Figure 3.1.1.1 Control Worksheet for SAMgator**

	A	B	C	D	E	F	G	H	I	J	K
	<p><b>Aggregation program for global SAM from GTAP data</b>  <b>This version also generates weighted averages of the GTAP elasticities ESUBD, ESUBM and ESUBVA. A correctly formulated input database is required.</b></p> <p><b>Options:</b></p> <p>GAMS.EXE location: <input type="text" value="C:\GAMS\GAMS.EXE"/> <input type="button" value="Test GAMS"/></p> <p>Pause after execution: <input checked="" type="checkbox"/></p> <p>.GDX file name</p> <p>Input <input type="text" value="worsam60_v3g.gdx"/></p> <p>Output <input type="text" value="samg23_5_18_ipts.gdx"/></p> <p>Aggregation program (.gms): <input type="text" value="globaggr_ipts1.gms"/></p> <p><input type="button" value="Write output file"/> <input type="button" value="Write to Sets sheet"/></p> <p><input type="button" value="Check for errors"/></p> <p><input type="button" value="Run aggregation"/></p>										

The user should now define the input file, which is required to be a GAMS Data Exchange (GDX) file; in this case the file is called 'worsam60\_v3g.gdx'.<sup>10</sup> Then name the output file; in this case 'samg23\_5\_18\_ipts.gdx', where the convention adopted is 'samgC\_F\_R\*\*.gdx' where C is the number of commodities and activities, F the number of factors and R the number of regions. And finally the user should provide a name for the GAMS programme file; in this case 'globaggr\_ipts1.gms'. The programme is not sensitive to the choice of naming conventions.

<sup>10</sup> GAMS has changed the formatting of GDX files over recent years. The changes are backward compatible but not forward compatible. This can lead to problem if the user wishes to access a more recent version of a GDX file that is not consistent with the version of GAMS being used; this should be rare. If it does happen there are two most obvious solutions; (1) recompile the input database using the more recent version of GAMS or (2) recompile the input database using the options in GAMS to write out GDX files in the earlier formats.

## Figure 3.1.1.2 Test GAMS



```

C:\WINDOWS\system32\cmd.exe
****
**** GAMS Development Corporation
**** 1217 Potomac Street, NW
**** Washington, DC 20007, USA
**** 202-342-0180, 202-342-0181 fax
**** support@gams.com, www.gams.com
****
**** BldDate : Nov 21, 2006
**** SysDir : C:\GAMS\
**** BldStamp: vis 22.3 <Nov 27, 2006>: Tue 21 Nov 03:03:17 PM EST 2006
**** License : C:\GAMS\gamslice.txt
****
**** Department of Economics                S060526:0542AL-WIN
**** University of Sheffield
**** DC109 01COM5PT                        0000
**** License for teaching and research at degree granting institutions
****
**** Status: Normal completion
---- Job ? Stop 02/05/07 15:22:52 elapsed 0:00:00.015

C:\Research\Miscellaneous Research\EU Food Industry\AnEFIS\IPTS_pc1_data>pause
Press any key to continue . . .

```

## 3.1.2 MappingConfig

The role of the 'MappingConfig' worksheet is to generate the sets for the aggregated SAM and set up the mappings, which will control the aggregation. The process has a number of safeguards built in to ensure there the mappings are legitimate and that there are no errors. Although users may choose to adapt a previous aggregation the description given here assumes that the user starts with a version of SAMgator that contains no aggregation specific set or mapping data.

Figure 3.1.2.1 illustrates how the 'MappingConfig' worksheet might look when there is no aggregation specific set or mapping data; the only difference between this image and the one seen when opening SAMgator is that the 'int\_k – Regions' line in the 'Category' box (top left) has been highlighted. The user needs to create sets and mappings for the commodities/activities, factors and regions.

## Figure 3.1.2.1 Mapping and Configuration Worksheet 1

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
													Check for Errors	
Category:			Elements in output set for this category:											
<div style="border: 1px solid black; padding: 2px;"> int_c - Commodities-Activiti  int_f - Factors  <b>int_k - Regions</b>  vstmarg - export margin acc </div>												Delete element    Move Up    Move Dn Edit    Auto Sort		
			Name: <input type="text"/> Add Descr: <input type="text"/>											
Elements in input set mapped to selected element in output set:				Unmapped elements in input set:										
				<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> &lt;&lt;&lt;   &lt;-   -&gt;   &gt;&gt;&gt; </div> <div style="border: 1px solid black; padding: 5px; width: 200px;"> aus - Australia  nzl - New Zealand  xoc - Rest of Oceania  chn - China  hkg - Hong Kong  jpn - Japan  kor - Korea  twn - Taiwan  xea - Rest of East Asia  idn - Indonesia  mys - Malaysia  phl - Philippines  sgp - Singapore  tha - Thailand  vnm - Vietnam  xse - Rest of Southeast Asia </div> </div>										

The steps undertaken to declare and define aggregate sets and to generate the mapping file are as follows.

1. Select a category: choose commodities/activities, factors or regions in the 'Category' box (top left).
2. Declare (and describe) an aggregate set element: type the name in the 'Name' box and below it a description in the 'Descr' box and then click the 'Add' button. This element will be a member of an output set for which each element will appear with its description in the 'Elements in output set for this category' box.
  - Note that SAMgator will use the sets and mappings to generate automatically multiple sets by PREFIXING letters (between 1 and 5 characters) to each element of the output set.
3. Select elements in the input set that are to be mapped to the selected member of the output set: select an element in the 'Elements in output set for this category' box and then select those elements that are to be mapped to that output set element from the 'Unmapped elements of input set' box (bottom right) by clicking on each in turn (NB the SHIFT and Ctrl click options do not operate). Click on the <- button to define the mapping. Note how the selected element of

the input set are moved to the 'Elements in input set mapped to selected element in output set' box (bottom left).

- The <- button moves selected elements in the unmapped element box to the mapped elements box; the -> button moves selected elements in the mapped element box to the unmapped elements box; the <<< button moves all elements in the unmapped element box to the mapped elements box; >>> button moves all elements in the mapped element box to the unmapped elements box.
  - Figure 3.1.2.2 illustrates that for the category 'int\_c – Commodities-Activities' the elements 'pdr – paddy rice', 'wht – wheat' and 'gro – cereal grains nec' of the input set are mapped to the element 'gran – grains' of the output set.
4. Continue adding elements to the output set in each category until all the elements in the input set are mapped to elements in the output set. Note how each element in the input set can only be mapped to one element in the output set – thereby avoiding 'double counting'. The error checking also checks to avoid duplicates in the output set.
  5. Ordering of the output set: as each new element of an output set is declared it is added to the end of the list of members if the output set for that category and this defines the set ordering that will be used by GAMS. The order of elements within an output set can be altered by selecting elements in the 'Elements in output set for this category' box and using the 'Move Up' and/or 'Move Down' buttons.<sup>11</sup>
  6. Deleting an output set element: select the element to delete in 'Elements in output set for this category' box and click on the 'Delete element' button.
  7. Select another category and complete steps 2 to 7 as appropriate until output sets and mapping sets for all three categories have been generated.

---

<sup>11</sup> Note that GAMS lists set members in the order that they were declared in the programme. If the same name, say 'abc', is used in 2 different sets this can create ordering problems for the user: assume that the order wanted for reports is the order of members in the second set declared, but because 'abc' is in the first set declared it will be the first member of the second set. Use names for members of sets that are unique to the sets to which they belong.

**Figure 3.1.2.2 Mapping and Configuration Worksheet 2**

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O			
													Check for Errors				
Category:			Elements in output set for this category:														
<div style="border: 1px solid black; padding: 2px;"> int_c - Commodities/Activities  int_f - Factors  int_k - Regions  vstmarg - export margin accounts </div>			<div style="border: 1px solid black; padding: 2px;"> gran - Grains  scb - Sugar cane and beet  oocp - Other crops  pbf - Plant based fibres  lstk - Livestock  mlk - Raw milk </div>									Delete element    Move Up    Move Dn Edit    Auto Sort					
												Name: <input type="text"/> Add Descr: <input type="text"/>					
Elements in input set mapped to selected element in output set:				Unmapped elements in input set:													
<div style="border: 1px solid black; padding: 2px;"> pdr - Paddy rice  wht - Wheat  gro - Cereal grains nec </div>				<<<  ← →  >>>			<div style="border: 1px solid black; height: 100px;"></div>										

### 3.1.3 Sets

The worksheet sets provides a full listing of the set names and descriptions required by the ANARRES model. These can be copied and pasted into the worksheet that contains set information for GLOBE\_cc.

## 3.2 Aggregation Guidelines

Some general guidelines for aggregations are given below. In the main these are common sense, but the note about the treatment of the Globe region (*glo*) is critical.

### 3.2.1 Account Aggregation

The aggregation of accounts in the global SAM is overwhelmingly a matter of the context for which the aggregation is being compiled; consequently the notes below are general and are not a replacement for economic reasoning and/or common sense.

- Aggregations across the categories (commodities-activities, factors, regions) of accounts are NOT economically appropriate even though they are mathematically possible. SAMgator prohibits such aggregations, and where the

aggregation is conducted using a different method the checks in the GLOBE model code will often identify such inappropriate aggregations<sup>12</sup>.

- Aggregations within categories should typically avoid mappings that are difficult to rationalise, e.g., aggregating unskilled labor with capital and keeping skilled labour separate, aggregating an agricultural commodity with a heavy manufacturing commodity.

### 3.2.2 *Treatment of the Globe region when aggregating*

The Globe region serves a special purpose in the GLOBE model since it handles all transactions for which full bi lateral data are absent. Consequently, Globe must never be part of an aggregate region and **MUST** be retained as a separate region in ALL implementations of the GLOBE model.

---

<sup>12</sup> The checks in the model code are not designed to identify such errors but they do identify entries in cells that are inappropriate and in such circumstances will cause the model to abort. However the error messages are not geared to the identification of problems associated with inappropriate aggregations.

#### 4. GAMS Data Exchange (GDX) Database

The GDX file produced by the SAMgator programme contains an aggregated global SAM in a format consistent with the ANARRES model and three series of elasticities that are aggregates of the elasticities reported in the GTAP database. The parameters in the GDX database are:

- NEWSAM – the aggregated global SAM in GLOBE format;
- ESUBD2 – Armington (CES) elasticities for level 1 domestic/(aggregate) import substitution, using domestic supply shares by value as weights;
- ESUBM2 – Armington (CES) elasticities for level 2 import substitution, using import supply shares by region as weights;
- ESUBM3 – Armington (CES) elasticities for level 2 import substitution, using domestic supply shares by value as weights;
- ESUBVA2 – elasticities of substitution between primary inputs, using factor shares by value as weights.
- NEW\_em\_CO2 – CO2 emissions by region and activity or household user of each energy commodity
- NEW\_EVol – Volume of input aggregate energy purchase by agent and region, tonnes of oil equivalent (toe)

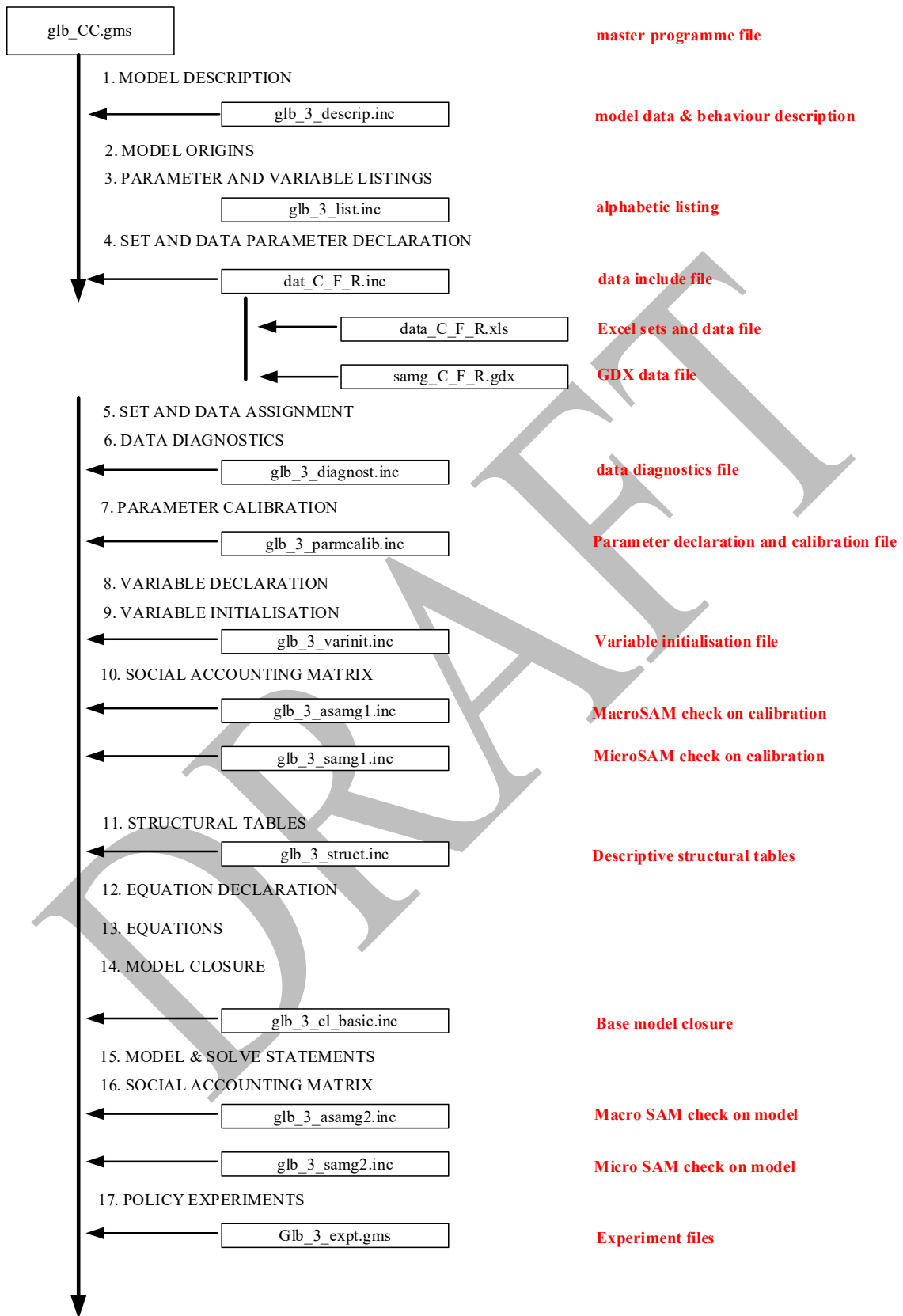
## 5. Structure of the ANARRES Model Code

The ANARRES programme code is relatively complex and consequently a modular structure is adopted; this takes the form of a series of *INCLUDE* files that are called from the main programme – \*\*\*.gms – file and two MS Excel workbooks that contain model and experiment/simulation data. In addition, the model makes use of number of *IF* statements that are used to control which modules are implemented in any particular run of the model. Finally, the model is set up to allow users, with minor adjustments, to implement the model using GAMS's *SAVE* and *RESTART* facility – this facility and its uses are not discussed in this User Guide.

A key element of the programming philosophy is that as far as possible all the data entry required by a typical user should be concentrated. For the base programme all the data entry is concentrated in two places – one *INCLUDE* file and one Excel workbook. In the experiment programme file all the data entry AND programming takes place in three places – one *INCLUDE* file each for set of simulations, multiple *INCLUDE* files for closure choices and one Excel workbook.

In this section, three schematics are presented to assist the user in understanding the structure of the programme's code. The first deals with the code for the basic model while the second relates to the template experiment file.

**Figure 5.1.1 ANARRES File Structure**



## 5.1 ANARRES Programme Structure

The schematic illustration of the structure of the ANARRES model file – `glb_CC.gms` – in Figure 5.1.1 is a reproduction of a schematic of the file structure included in the programme file. The place in the core programme where each *INCLUDE* file is called is shown together with the titles to each of the sections of the core programme file. In addition the descriptions down the right hand side indicate the role each *INCLUDE* file plays in the programme. The majority of the *INCLUDE* files only need attention if the user is making changes to the core model code. However there are two ‘areas’ to which the user needs to pay attention:

- `dat_C_F_R.inc` – data entry file
- `glb3_expt_template.inc` – experiment file

these are explored in detail below, using extracts from the model code files.

DRAFT

## 6. Model Data and Conditioning File

The data entry file - `dat_C_F_R.inc` - is extensively documented at the top of the file; the notes here are designed to assist the user rather than replace the information provided there.

### 6.1 Data Entry Section

In this section the user makes the necessary entries to change the data sets provided to the model. There are 6 sub sections.

- 1a. Excel workbook sets and data converted to gdx here  
The user replaces [filename] with the appropriate filename for the new Excel data file in GDXXRW call statement. i.e.,  
`$CALL "GDXXRW i=[filename].xls o=data_in.gdx INDEX=LAYOUT!A4"`
- 1b. All data, elasticities and sets from Excel are assigned here  
There should be no need to make changes here unless the model is being changed.
- 1c. All GTAP transactions and elasticity data are assigned here  
The user replaces [filename] with the appropriate filename for the new GDX data filename in the \$GDXIN statement  
`$GDXIN [filename].gdx`
- 1d. Controlling for elasticity data for GLB region  
There should be no need to make changes here unless the model is being changed.
- 1e. Defining SETS by exclusions from previously defined SETS  
There should be no need to make changes here unless the model is being changed.
- 1f. Defining MAPPING SETS by using subset information  
There should be no need to make changes here unless the model is being changed.

The user needs to enter the appropriate Excel file name in place of the 'DATA\_C\_F\_R.xls' file currently called by the GDXXRW programme (see below for details about compiling model's Excel file.

```
*---- 1a. Excel workbook sets and data converted to gdx here
```

```
* Convert Excel workbook data to GDX here
$CALL "GDXXRW i=DATA_C_F_R.xls o=data_in.gdx INDEX=LAYOUT!A4"
```

The user also needs to identify the GDX file that contains the data. The user needs to enter the appropriate GDX file name in place of the 'SAMG\_C\_F\_R.xls' file currently called by GDXIN (see above for details about compiling model's data file using SAMgator).

```
*---- 1c. All GTAP transactions and elasticity data are assigned here
$ontext
  Read in GTAP data and elasticities from GDX file. Data are read for
  all regions as SAMG. In SAMG(*,*,*), the third index refers to the
  country SAM. This also holds in the model for all parameters,
  variables, and eqns. The last index always refers to the region. Where
  there are three indices these should be read as referring to the row,
  then column of the SAM and then the region.
$offtext

$GDXIN SAMGC_F_R.gdx

* LOAD transactions/SAMG data
$LOAD SAMG = NEWSAM

* Loading GTAP elasticities
$LOAD elastmg = esubd2 elastvag = esubva2 elastrmg = esubm2

$GDXIN
```

## 6.2. Removing Very Small Values from SAMG

This section eliminates all transaction below the value of `mod_cont("mintrans")`, which is set in the Excel workbook. This is implemented on the base data, i.e., before scaling, and the value should typically be less than 0.0001. The truncated data are checked and the SAMG passed to the next stage and unloaded as 'samgmod.gdx'.

Typically, there is no need for the user to make changes in this section.

### 6.3. Automatic Scaling of Values in SAMG

This section uses `mod_cont("scalprop")` and `mod_cont("scaltarg")` that are set in the Excel workbook to control automatic scaling. The default values of `mod_cont("scalprop")` and `mod_cont("scaltarg")` are 0.95 and 100.

There is usually no need for the user to make changes in this section.

### 6.4 Assigning Final Model Transaction and Factor Use Data

This section assigns the final SAMG and FACTUSE data used by the model and carries out some checks before sending the model SAM to a GDX file.

- 4a. Scaling transactions data  
This uses `samscale` from section 3.
- 4b. Assigning and scaling factor use data  
This section assigns the SAMG values as the default values for the FACTUSE matrix. Alternative data can be used if they are known.
- 4c. Checking the data used in the model  
The model data are checked and the SAMG used in the model is unloaded as `'samgmod.gdx'`.

### 6.5. Assigning Sets to Control Model Structure

This section contains instructions that affect the structure of the model. This is all done by set assignment statements many of which come from information supplied by the Excel workbook, but facilities exist for manual changes; this is sometimes the easiest way to get fine control over the model structure.

- 5a. Defining sets to control production nesting structure  
This uses the data and the sets `aleon` and `rleon` from the worksheet 'mod\_sets' to set `aqx` and `aqxn`. A manual option is also available. `aqxn` is the complement to `aqx`.

## 7. Compiling the Model's Excel Workbook<sup>13</sup>

Typically, the model uses two Excel workbooks to contain the information used by the model; the first workbook contains information used for calibrating the model, while the second provides information used to run simulations. While this arrangement increases the number of files a user has to access and pass to the model it does have advantages in flexibility and replicability. This section is concerned with the Excel workbook that has information used to calibrate the model.

### 7.1 Model Sets

#### 7.1.1 Sets Worksheet

The 'sets' worksheet contains the vast majority of the sets and subsets used by the model. There are two major sets, *sac* and *r*, where *sac* contains all the accounts for a single region and *r* the set of regions in the model. The member and descriptions for *sac* and *r* can be obtained by copying and pasting from the SAMgator file used to generate the aggregate SAM. Some elements will need to be added to account for aggregates in the production nesting structure and the use of commodities in value added. The user defines the aggregate factors and the factor commodities. Details are given later in this section. It is important to ensure that the set member names and descriptions are pasted into the correct cells in the workbook and worksheet, if not errors will be generated. How the first few columns of the 'sets' worksheet look to the user is shown in Figure 7.1.1.1.

---

<sup>13</sup> GAMS uses a programme, GDXXRW, to convert the information in an Excel workbook into a GDX file using information drawn from a worksheet in the workbook – for GLOBE this 'master' worksheet is called 'Layout'. The 'Layout' worksheet contains information that instructs GDXXRW about the 'Data Type', 'Name (of the data)', 'Location (of the data)', 'Row dimension (of the data)', 'Column dimension (of the data)', 'Total dimension (of the data)'. If the user chooses to put data in different places to those in the sample Excel workbook errors will be generated unless the 'Layout' workbook is modified. For instructions about using GDXXRW see the help menu in GAMSIDE (> Help > docs > gams > gdxutils.chm or gdxutils.pdf).

**Figure 7.1.1.1** Sets Worksheet Part 1

	A	B	C	D	E	F	G
1	Sets						
2							
3	<b>New SAM accounts</b>			<b>Regions</b>			<b>Regional Accounts for numeraire</b>
4	<b>sac</b>	<b>(description)</b>		<b>r</b>	<b>(description)</b>		<b>ref</b>
5	cgrain	grain		W_Afr	West Africa		W_Afr
6	cothr_ag	other agriculture		N_Afr	North Africa		N_Afr
7	coilseed	oilseed		E_Afr	East Africa		E_Afr
8	clvstk	livestock		SACU	South African Customs Union		SACU
9	ccoal	coal		Othr_Asia	Other Asia		Othr_Asia
10	coil_ext	oil extraction		Othr_S_Asia	Other South Asia		Othr_S_Asia
11	cgas_ext	gas extraction		C_Amer	Central America		C_Amer
12	cmine	other mining extraction		Othr_L_Amer	Other Latin America		Othr_L_Amer
13	cmeat	cattle and other meat		Brazil	Brazil		Brazil
14	cv_oil	vegetable oils and fats		China_HK	China and Hong Kong		China_HK
15	cothr_food	other food		Russ	Russian federation		Russ
16	ctext	textiles and wearing apparel		India	India		India
17	cleath	leather products		Mid_East	Middle East		Mid_East
18	cwood	wood and paper		Othr_Eur	Other Europe		Othr_Eur
19	cpetro	coke and refined petroleum		Fmr_SU	Former soviet union		Fmr_SU
20	cchem	chemicals		Aus_Nzl	Australia and New zealand		Aus_Nzl
21	cpharma	basic pharmaceutical product		NAFTA	US Canada Mexico and Puerto Rico		NAFTA
22	cothr_mfg	other manufacturing		EU_27	EU 27		EU_27
23	cmetal	metals		H_Asia	High-income Asia		H_Asia
24	ctransp	transport equipment		Glb	Globe		Glb
25	celec	electricity					
26	cgas_dst	gas distribution					
27	cconstr	construction					
28	ctmosp	transport services					
29	ctrd_svc	services to facilitate the delivery of goods					
30	cothr_svc	other services					
31	cfm_svc	financial services					
32	agrain	grain					
33	aotr_ag	other agriculture					
34	aoilseed	oilseed					
35	alvstk	livestock					
36	acoal	coal					

Note that in addition to the sets *sac* and *r* Figure 7.1.1.1 also contains a third set *ref*. This set is a subset of *r* that defines the regions that are included in the exchange rate index used by the model. The members of *ref* are selected by the user subject to the following conditions:

- *ref* must contain at least one member of *r*; and
- *ref* must NOT contain *glb*.

The model uses a substantial number of subsets of *sac*; some of these are shown in Figure 7.1.1.2. The main subsets are

- *c(sac)* commodity accounts
- *a(sac)* activity accounts

ANARRES: A User Guide

- *ff(sac)* aggregate and natural factor accounts<sup>14</sup>
- *tmr(sac)* tariff accounts
- *ter(sac)* export subsidy accounts
- *tsd(sac)* sales tax adjustments for domestic demand
- *tff(sac)* factor tax account
- *h(sac)* household accounts
- *g(sac)* government accounts
- *i(sac)* investment accounts
- *owatpmarg(sac)* Trade and transportation margin services
- *w(sac)* Rest of world trade partners

The user needs to manually assign these subsets when setting up a new version of the GLOBE model. It is a sensible practice to copy and paste the subsets from the column containing the *sac* account names so as to avoid typing errors. NB the GLOBE programme will abort if the accounts names in *sac* and ALL the subsets are NOT identical.

In addition to the subsets of *sac* there are a number of subsets of the subsets of *sac*.

These are

- *cagr(c)* Agricultural commodities
- *cnat(c)* Natural resource commodities
- *cf(c)* Food commodities
- *cind(c)* Industrial commodities
- *cuti(c)* Utility commodities
- *cser(c)* Service commodities
- *cf(c)* Commodity factors
- *aagr(a)* Agricultural activities
- *anat(a)* Natural resource activities
- *afd(a)* Food activities
- *aind(a)* Industrial activities
- *auti(a)* Utility activities
- *aser(a)* Service activities
- *a\_k\_fx(a)* Activities with fixed capital

<sup>14</sup> The natural factors are all factors that appear in SAMG. The aggregate factors are constructed to facilitate nesting in the production structure.

ANARRES: A User Guide

- $f(ff)$  Natural factors
- $fag(ff)$  Aggregate factors
- $fc(ff)$  Factor commodities
- $l(f)$  Labour Factors
- $ls(l)$  Skilled Labour Factors
- $lu(l)$  Unskilled Labour Factors
- $k(f)$  Capital Factors
- $kfx(k)$  Immobile capital factors
- $lnd(f)$  Land factors

The user needs to define the memberships of these subsets manually following conventions that are obvious from the naming of the subsets. Again, copying and pasting is a way to avoid typing errors. The subsets of  $c$  (with the exception of  $cf(c)$ ), and  $a$  are used extensively in standardised summary statistics used to describe the database and/or analyse results from model simulations; inappropriate assignments will produce tables of results that contain limited and/or misleading information. Empty subsets of  $c$  and  $a$  are legitimate. The subset of  $c$ ,  $cf(c)$  identifies commodities that are treated as factors and used in the value-added production nest. The subsets of  $ff$  are primarily used to define the nesting structure in production. The subsets of  $f$  are primarily used for model and simulation purposes.

NB: The sets  $cagg$  and  $aagg$  are fixed and the user should not change them unless they intend to make substantial changes throughout the files that are used to analyse results. If the user wants additional subsets for the analysis of specific aspects of the results they should declare and assign those subsets – typically in the experiment files and associated Excel workbooks.

**Figure 7.1.1.2** Sets Worksheet Part 2

I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Commodities	Commodity factors	Agricultural Commodities	Natural Resource Commodities	Food Commodities	Industrial Commodities	Construction Commodities	Utility Commodities	Service Commodities	Commodity Groups	Activities	Agricultural Activities	Natural Resource Activities	Food Activities
c	cf	cagr	cnat	cfid	cind	ccns	cuti	cser	cagg	a	aagr	anat	afd
cgrain	ccoal	cgrain	ccoal	cmeat	ctext	cconstr	celec	ctrnsp	cagr	agrain	agrain	acoal	ameat
cothr_ag	coil_ext	cothr_ag	coil_ext	cv_oil	cleath		cgas_dst	ctrd_svc	cnat	aothr_ag	aothr_ag	aoil_ext	av_oil
coilseed	cgas_ext	coilseed	cgas_ext	cothr_food	cwood			cothr_svc	cfd	aoilseed	aoilseed	agas_ext	aothr_food
clvstk	cpetro	clvstk	cmine		cpetro			cfm_svc	cind	alvstk	alvstk	amine	
ccoal	celec				cchem				ccns	acoal			
coil_ext	cgas_dst				cpharma				cuti	aoil_ext			
cgas_ext					cothr_mfg				cser	agas_ext			
cmine					cmetal					amine			
cmeat					ctransp					ameat			
cv_oil										av_oil			
cothr_food										aothr_food			
ctext										atext			
cleath										aleath			
cwood										awood			
cpetro										apetro			
cchem										achem			
cpharma										apharma			
cothr_mfg										aothr_mfg			
cmetal										ametl			

### 7.1.2 Maps Worksheet

In a number of calibration statements and equations in the model it is necessary to match data that are recorded using slightly different but related labels. This requires the provision of a series of mapping sets that define the matching of set elements. These mapping sets are defined in the ‘maps’ worksheet. The user needs to compile this worksheet; this is illustrated in Figure 7.1.2.1.

The standard format for a mapping set is ‘map\_set1\_set2(set1,set2)’. ‘map\_set1\_set2’ is the name of the mapping set, and (set1,set2) define the two sets that are mapped where set1 is the destination set and set2 is the source set. Thus ‘map\_set1\_set2(set1,set2)’ defines the mapping of the elements in set2 onto the elements in set1. The user needs to enter the sets in the appropriate columns of the ‘maps’ worksheet. When compiling these mapping sets it is important to be very careful to ensure the mappings are correct. Notice how in all cases bar one (see below) that set1 and set2 have common suffixes; these must always match. If the set sac is constructed from correctly ordered output from SAMgator then the ordering within the subsets of sac will be consistent and the ‘maps’ worksheet can be compiled by copying and pasting from the subsets of sac.<sup>15</sup>

<sup>15</sup> Note, mapping sets can also be done directly in the GAMS code, if the elements of the sets to be mapped are from consistently ordered sets, i.e. the arguments of each set are ordered such that the mapping is correct.

Figure 7.1.2.1 Maps Worksheet

	A	B	C	D	E	F	G	H	I	J	K	L
1	Maps											
2												
3												
4	<b>map_c_w_marg(c,w,owatpmarg)</b>				<b>map_marg_w(owatpmarg,w)</b>			<b>map_wagg_w(wagg,w)</b>			<b>map_ragg_r(ragg,r)</b>	
5	ctrnsp	wW_Afr	owatpW_Afr		owatpW_Afr	wW_Afr		wW_Afr	wW_Afr		W_Afr	W_Afr
6	ctrnsp	wN_Afr	owatpN_Afr		owatpN_Afr	wN_Afr		wN_Afr	wN_Afr		N_Afr	N_Afr
7	ctrnsp	wE_Afr	owatpE_Afr		owatpE_Afr	wE_Afr		wE_Afr	wE_Afr		E_Afr	E_Afr
8	ctrnsp	wSACU	owatpSACU		owatpSACU	wSACU		wSACU	wSACU		SACU	SACU
9	ctrnsp	wOthr_Asi	owatpOthr_Asia		owatpOthr_Asi	wOthr_Asia		wOthr_Asi	wOthr_Asia		Othr_Asia	Othr_Asia
10	ctrnsp	wOthr_S_	owatpOthr_S_Asia		owatpOthr_S_	wOthr_S_Asia		wOthr_S_	wOthr_S_Asia		Othr_S_A:	Othr_S_Asia
11	ctrnsp	wC_Amer	owatpC_Amer		owatpC_Amer	wC_Amer		wC_Amer	wC_Amer		C_Amer	C_Amer
12	ctrnsp	wOthr_L_	owatpOthr_L_Amer		owatpOthr_L_	wOthr_L_Amer		wOthr_L_	wOthr_L_Amer		Othr_L_Ar	Othr_L_Amer
13	ctrnsp	wBrazil	owatpBrazil		owatpBrazil	wBrazil		wBrazil	wBrazil		Brazil	Brazil
14	ctrnsp	wChina_HI	owatpChina_HK		owatpChina_H	wChina_HK		wChina_HI	wChina_HK		China_HK	China_HK
15	ctrnsp	wRuss	owatpRuss		owatpRuss	wRuss		wRuss	wRuss		Russ	Russ
16	ctrnsp	wIndia	owatpIndia		owatpIndia	wIndia		wIndia	wIndia		India	India
17	ctrnsp	wMid_Eas	owatpMid_East		owatpMid_Eas	wMid_East		wMid_Eas	wMid_East		Mid_East	Mid_East
18	ctrnsp	wOthr_Eur	owatpOthr_Eur		owatpOthr_Eur	wOthr_Eur		wOthr_Eur	wOthr_Eur		Othr_Eur	Othr_Eur
19	ctrnsp	wFmr_SU	owatpFmr_SU		owatpFmr_SU	wFmr_SU		wFmr_SU	wFmr_SU		Fmr_SU	Fmr_SU
20	ctrnsp	wAus_Nzl	owatpAus_Nzl		owatpAus_Nzl	wAus_Nzl		wAus_Nzl	wAus_Nzl		Aus_Nzl	Aus_Nzl
21	ctrnsp	wNAFTA	owatpNAFTA		owatpNAFTA	wNAFTA		wNAFTA	wNAFTA		NAFTA	NAFTA
22	ctrnsp	wEU_27	owatpEU_27		owatpEU_27	wEU_27		wEU_27	wEU_27		EU_27	EU_27
23	ctrnsp	wH_Asia	owatpH_Asia		owatpH_Asia	wH_Asia		wH_Asia	wH_Asia		H_Asia	H_Asia
24	ctrnsp	wGlb	owatpGlb		owatpGlb	wGlb		wGlb	wGlb		Glb	Glb

One complication in the ‘maps’ worksheet is the mapping set  $\text{map\_c\_w\_marg}(c, w, \text{owatpmarg})$ , which is a triple. The complexity here derives from the presence of the mapping to the set  $c$ . Since both  $w$  and  $\text{owatpmarg}$  are sets based on the regions the mapping here is straightforward since it involves matching regions, but  $c$  refers to types of trade margins of which there can be three. Thus, when constructing this mapping set each pairing of  $w$  and  $\text{owatpmarg}$  needs to be repeated for each member of  $c$ , i.e., for each commodity that is used as a trade margin.

### 7.1.3 Set for Commodity Factors

The worksheet, ‘fact\_comm’ assigns commodities that will be used as factors in the value added production nest, rather than intermediates with fixed input-output coefficients. The elements of the set  $\text{cfa}(c, a)$  are identified. See Figure 7.1.3.1.

**Figure 7.1.3.1 Commodity Factors Worksheet**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Sets for Factor Commodities in Nests																
2																	
3	cfa(c,a)																
4																	
5		agrain	aotr_ag	aoilseed	alvstk	acoal	aoil_ext	agas_ext	amine	ameat	av_oil	aotr_foo	atext	aleath	awood	apetro	act
6	cgrain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	cothr_ag	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	coilseed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	clvstk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	ccoal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	coil_ext	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	cgas_ext	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	cmine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	cmeat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	cv_oil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	cothr_food	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	ctext	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	cleath	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	cwood	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	cpetro	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	cchem	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	cpharma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	cothr_mfg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	cmetal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	ctransp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	celec	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
27	cgas_dst	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
28	cconstr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	ctrmsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	ctrd_svc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	cothr_svc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	cln_svc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33																	
34																	
35																	
36																	
37																	

7.1.4 Model Sets

The final worksheet of sets for the model is ‘mod\_sets’. This worksheet defines subsets that are used to control behavioural attributes of the model. Specifically, there are two behavioural attributes that are covered; the identification of activities and regions for which the top level of the production nests are characterised by zero substitution. The default setting in the model is that the top-level nest is a CES nest and therefore the user specifies only those activities and regions for which the Leontief option is wanted. (NB There is a minimum intermediate input share for which the CES default operates; this can be changed in the ‘controls’ worksheet – see below).

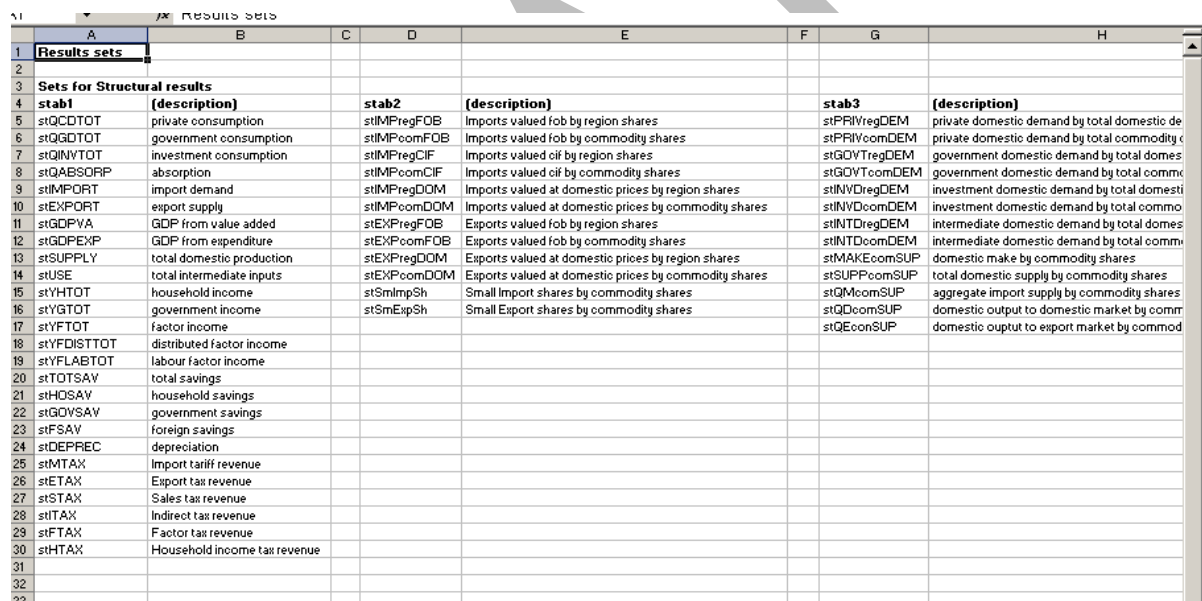
**Figure 7.1.4.1 Model Sets Worksheet**

	A	B	C
1	<b>Model Structure Sets</b>		
2			
3	<b>Sets to control production structure Level 1</b>		
4	<b>aleon</b>	<b>rleon</b>	
5			
6			
7			
8			
9			
10			

This worksheet of sets is something of an anomaly; while it is included in the data workbook it apparently refers to actions that take place in the experiment file. The reason is simple. This worksheet contains sets that are used in the generation of the descriptive statistics module (`glb3_struct.inc`) that provides structural information about the underlying database, and this module is implemented during the model set up and calibration phase. This allows the analyst to evaluate the data, and choice of aggregation, before conducting experiments.

The sets in this worksheet will only change if the analyst chooses to extend the files that generate aggregated results. This is a straightforward process if the objective is to simply add another summary statistic to the already define parameters: the additional set member is added to the already defined set and the calculations required to compute the new summary statistics are added to the appropriate results analyses files and/or the descriptive structural file.

**Figure 7.1.5.1 Results Set Worksheet**



1	A	B	C	D	E	F	G	H
2	Results sets							
3	<b>Sets for Structural results</b>							
4	<b>stab1</b>	<b>(description)</b>	<b>stab2</b>	<b>(description)</b>	<b>stab3</b>	<b>(description)</b>		
5	stQCDTOT	private consumption	stIMPregFOB	Imports valued fob by region shares	stPRIVregDEM	private domestic demand by total domestic de		
6	stQGDTOT	government consumption	stIMPcomFOB	Imports valued fob by commodity shares	stPRIVcomDEM	private domestic demand by total commodity c		
7	stQINVTOT	investment consumption	stIMPregCIF	Imports valued cif by region shares	stGOVTregDEM	government domestic demand by total domes		
8	stQABSORP	absorption	stIMPcomCIF	Imports valued cif by commodity shares	stGOVTcomDEM	government domestic demand by total commo		
9	stIMPORT	import demand	stIMPregDOM	Imports valued at domestic prices by region shares	stINVDregDEM	investment domestic demand by total domesti		
10	stEXPORT	export supply	stIMPcomDOM	Imports valued at domestic prices by commodity shares	stINVDcomDEM	investment domestic demand by total commo		
11	stGDPYA	GDP from value added	stEXPregFOB	Exports valued fob by region shares	stINTDregDEM	intermediate domestic demand by total domes		
12	stGDPEXP	GDP from expenditure	stEXPcomFOB	Exports valued fob by commodity shares	stINTDcomDEM	intermediate domestic demand by total commo		
13	stSUPPLY	total domestic production	stEXPregDOM	Exports valued at domestic prices by region shares	stMAKEcomSUP	domestic make by commodity shares		
14	stUSE	total intermediate inputs	stEXPcomDOM	Exports valued at domestic prices by commodity shares	stSUPPcomSUP	total domestic supply by commodity shares		
15	stYHTOT	household income	stSmImpSh	Small Import shares by commodity shares	stQMcomSUP	aggregate import supply by commodity shares		
16	stYGTOT	government income	stSmExpSh	Small Export shares by commodity shares	stQDcomSUP	domestic output to domestic market by comr		
17	stYFTOT	factor income			stQEcomSUP	domestic output to export market by commod		
18	stYFDISTTOT	distributed factor income						
19	stYFLABTOT	labour factor income						
20	stTOTSAV	total savings						
21	stHOSAV	household savings						
22	stGOVSAV	government savings						
23	stFSAV	foreign savings						
24	stDEPPREC	depreciation						
25	stMITAX	Import tariff revenue						
26	stETAX	Export tax revenue						
27	stSTAX	Sales tax revenue						
28	stITAX	Indirect tax revenue						
29	stFTAX	Factor tax revenue						
30	stHTAX	Household income tax revenue						
31								
32								
33								

## 7.2 Elasticities

In addition to the transactions data derived from the (aggregate) SAM the model also needs a series of elasticities. The elasticities included in the GTAP database are made available to the model through the GDX database produced by the SAMgator programme, but the GTAP model, and hence the GTAP database, does not use as many exogenous elasticities as ANARRES. In particular ANARRES has a multi-level production nest where the top level can be CES – the default – or Leontief – as in the GTAP model and value added can have

multiple, user-defined CES functions, CET functions on the export side and a linear expenditure system. Thus GLOBE requires a number of elasticities that are not included in the GTAP database and moreover, because of the use of CET functions for exports, the ‘high’ values of the import substitution elasticities in the GTAP database can be reduced.<sup>16</sup>

The user has (broadly) three choices as to the elasticities used by the model; user defined elasticities that are supplied to the model from Excel, GTAP based elasticities that are supplied in the GDX database, or some combination of the two. The user makes this choice through the `mod_control` parameters that are described in section 7.3. This section describes the format used to record elasticity data in Excel.

### 7.2.1 Import Substitution Elasticities

Import substitution elasticities are needed for both levels of the Armington functions. These are recorded in two worksheets, ‘`comelastm`’ and ‘`comelastrm`’, where the former contains the elasticities of substitution between aggregate imports and domestic commodities (model parameter *ELASTM*) and the latter the elasticities of substitution between aggregate imports from different regions (model parameter *ELASTRM*). Both are two dimensional matrices that allow for differences in the substitution elasticities by commodity and region.<sup>17</sup> The user needs to define the row and column accounts from the sets *c* and *r* that are determined by the aggregation used; this is illustrated in Figure 7.2.1.1.

The determination of appropriate elasticities is the responsibility of the user; the numbers in the model template are placeholders **only**.

<sup>16</sup> It is argued that GTAP uses ‘high’ substitution elasticities so that the terms of trade effects are ‘damped down’ and that part of reason that the GTAP model can produce large terms of trade effects is the fact that export supplies are driven by import demands. When there is a CET function on exports domestic producers are able to reallocate output between export and domestic markets in response to changes in export prices, thereby ‘damping down’ the terms of trade effects for any given set of import substitution elasticities. But the interaction effects between Armington and CET elasticities are not fully worked out.

<sup>17</sup> This is different to the case in the GTAP model where the substitution elasticities are common across regions and are only differentiated by commodity.

**Figure 7.2.1.1 Import Substitution Elasticities for GLOBE Model**

	A	B	C	D	E	F	G	H	I	J	K	L
3												
4	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM				
5		W_Afr	N_Afr	E_Afr	SACU	Othr_Asia	Othr_S_A	C_Amer	Othr_L_A	Brazil	China_F	
6		cgrain	2.63347	3.56674	2.30135	3.17113	4.46431	4.67005	2.70756	2.83811	2.5799	3.2181
7		cothr_ag	2.02106	2.41816	2.33022	2.131	2.04618	2.52596	2.37534	2.44281	2.5817	2.028
8		coilseed	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.45	2.4
9		clvstk	1.78112	1.64482	1.77077	1.7338	1.4369	1.5486	1.49107	1.65927	1.69816	1.4703
10		occoal	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.0
11		coil_ext	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.
12		cgas_ext	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.
13		cmine	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.
14		cmeat	3.94654	4.01552	4.09121	4.11434	4.22347	4.02603	4.1917	4.12867	4.04798	4.3070
15		cv_oil	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.
16		cothr_foo	2.01252	2.21563	1.92997	1.91622	2.07597	2.5305	2.08596	2.04996	2.15194	1.9266
17		clext	3.72631	3.72631	3.72476	3.72374	3.73195	3.73306	3.72106	3.72224	3.72614	3.7336
18		cleath	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.0
19		cwood	3.22118	3.2192	3.136	3.07086	3.14455	3.05678	3.0755	3.12442	3.06023	3.127
20		cpetro	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.
21		cchem	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.
22		cpharma	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.
23		cothr_mfg	3.89745	3.75383	3.8088	3.86387	4.00804	3.72099	3.83322	3.75412	3.88917	3.9175
24		cmetal	3.74312	3.57672	3.68705	3.61518	3.59674	3.61204	3.52863	3.62541	3.4644	3.5208
25		ctransp	3.80186	3.1014	3.18778	2.98876	3.32647	3.4705	3.56356	3.15106	3.0339	3.1148
26		celec	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.
27		cgas_dst	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.
28		coonstr	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.
29		ctrnsp	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.
30		ctrd_svc	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.
31		cothr_svc	1.95609	1.99054	2.00059	1.98373	1.96239	2.02379	1.95583	1.95641	1.97197	1.9793
32		cfin_svc	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.
33												
34												

### 7.2.2 Export Transformation Elasticities

Export transformation elasticities are needed for both levels of the CET functions. These are recorded in two worksheets, ‘comelaste’ and ‘comelastre’, where the former contains the elasticities of transformation between aggregate exports and domestic commodities (model parameter *ELASTE*) while the latter worksheet contains the elasticities of transformation between aggregate exports to different regions (model parameter *ELASTRE*). Both are two dimensional matrices that allow for differences in the transformation elasticities by commodity and region.<sup>18</sup> The user needs to define the row and column accounts from the sets *c* and *r* used determined by the aggregation used; this is illustrated in Figure 7.2.1.2.

The determination of appropriate elasticities is the responsibility of the user; the numbers in the model template are placeholders **only**.

<sup>18</sup> There is no equivalent to the CET elasticities in the GTAP model because of differences in behavioural assumptions. When CET elasticities are derived from the GTAP database they are in fact based on the Armington elasticities used by GTAP.

**Figure 7.2.1.2** Export Transformation Elasticities for GLOBE Model

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	<b>Model Specific Commodity Elasticities</b>												
2	Elasticities												
3													
4	ELASTE	ELASTE	ELASTE	ELASTE	ELASTE	ELASTE	ELASTE						
5		W_Afr	N_Afr	E_Afr	SACU	Othr_Asia	Othr_S_A	C_Amer	Othr_L_A	Brazil	China_HK	Russ	
6		ograin	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7		cothr_ag	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8		oilseed	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9		clvstk	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10		ccoal	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
11		coil_ext	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
12		cgas_ext	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
13		omine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
14		cmeat	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
15		cv_oil	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
16		cothr_foo	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
17		ctext	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
18		cleath	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
19		cwood	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
20		cpetro	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
21		cchem	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
22		opharma	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
23		cothr_mfg	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
24		cmetal	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
25		ctransp	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
26		celec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
27		cgas_dst	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
28		cconstr	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
29		ctrnsp	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
30		ctrd_svc	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
31		cothr_svc	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
32		cfm_svc	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
33													

### 7.2.3 Production Function Elasticities

Substitution elasticities are required for both levels of the nested CES production functions. These are recorded in two worksheets, ‘actelastx’ and ‘actelastva’, where the former contains the elasticities of substitution between aggregate intermediate inputs and aggregate value added (model parameter *ELASTX*) and the latter the elasticities of substitution between primary inputs (model parameter *ELASTVA*). Both are two dimensional matrices that allow for differences in the substitution elasticities by activity and region.<sup>19</sup> The user needs to define the row and column accounts from the sets *a* and *r* used determined by the aggregation used; this is illustrated in Figures 7.2.3.1 and 7.2.3.2.

<sup>19</sup> This is different to the case in the GTAP model where the top level of the production nest is fixed as Leontief, i.e., zero substitution elasticities. When CES elasticities are derived from the GTAP database they are in fact based on the value added substitution elasticities used by GTAP.

**Figure 7.2.3.1 Production Elasticities between Aggregate Intermediate and Aggregate Value Added for GLOBE Model**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	<b>Model Specific Activity Elasticities</b>															
2	Elasticities															
3																
4	ELASTX	ELASTX	ELASTX	ELASTX	ELASTX	ELASTX	ELASTX									
5		w_Afr	N_Afr	E_Afr	SACU	Othr_Asia	Othr_SA	C_Amer	Othr_LA	Brazil	China_HK	Russ	India	Mid_East	Othr_Eu	
6		agrain	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
7		aothr_ag	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
8		aoilseed	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
9		alvstk	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
10		acoal	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
11		aoil_ext	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
12		agas_ext	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
13		amine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
14		ameat	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
15		av_oil	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
16		aothr_foo	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
17		atext	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
18		aleath	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
19		awood	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
20		apetro	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
21		achem	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
22		apharma	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
23		aothr_mfg	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
24		ametl	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
25		atransp	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
26		aelec	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
27		agas_dst	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
28		aconstr	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
29		atrsp	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
30		atrd_svc	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
31		aothr_svc	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
32		afin_svc	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.0
33																

DRAFT

**Figure 7.2.3.2 Production Elasticities among Inputs to Value Added for GLOBE Model**

	A	B	C	D	E	F	G	H	I	J	K
1	<b>Model Specific Activity Elasticities</b>										
2	Elasticities										
3											
4	<b>ELASTVA</b>	ELASTVA	ELASTVA	ELASTVA	ELASTVA	ELASTVA	ELASTVA				
5		W_Afr	N_Afr	E_Afr	SACU	Othr_Asi	Othr_S_A	C_Amer	Othr_L_A	Brazil	
6	agrain	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084
7	aothr_ag	0.25458	0.25419	0.24417	0.22816	0.23165	0.2509	0.25014	0.24888	0.2533	0.2533
8	aoilseed	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084
9	alvstk	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084	0.26084
10	acoal	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0
11	aoil_ext	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0
12	agas_ext	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0
13	amine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0
14	ameat	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1
15	av_oil	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1
16	aothr_foo	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1
17	atext	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
18	aleath	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
19	awood	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
20	apetro	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
21	achem	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
22	apharma	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
23	aothr_mfg	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
24	ametel	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
25	atransp	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
26	aelec	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
27	agas_dst	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
28	aconstr	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1
29	atrnsp	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
30	atrd_svc	1.62897	1.56906	1.59797	1.55878	1.61623	1.66293	1.58759	1.57188	1.5623	1.5623
31	aothr_svc	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
32	afin_svc	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26	1.26
33											

DK

**Figure 7.2.3.3 Production Elasticities among Inputs in Production Nest for GLOBE Model**

	A	B	C	D	E	F	G	H	I	J	K	L
1	<b>Model Specific Activity Elasticities</b>											
2	Elasticities											
3												
4	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD	ELASTFD
5				W_Afr	N_Afr	E_Afr	SACU	Othr_Asia	Othr_SA	C_Amer	Othr_L_A	Brazil
6		flab	agrain	4	4	4	4	4	4	4	4	4
7		flab	aotr_ag	4	4	4	4	4	4	4	4	4
8		flab	aoilseed	4	4	4	4	4	4	4	4	4
9		flab	alvstk	4	4	4	4	4	4	4	4	4
10		flab	acoal	4	4	4	4	4	4	4	4	4
11		flab	aoil_ext	4	4	4	4	4	4	4	4	4
12		flab	agas_ext	4	4	4	4	4	4	4	4	4
13		flab	amine	4	4	4	4	4	4	4	4	4
14		flab	ameat	4	4	4	4	4	4	4	4	4
15		flab	av_oil	4	4	4	4	4	4	4	4	4
16		flab	aotr_foo	4	4	4	4	4	4	4	4	4
17		flab	atext	4	4	4	4	4	4	4	4	4
18		flab	aleath	4	4	4	4	4	4	4	4	4
19		flab	awood	4	4	4	4	4	4	4	4	4
20		flab	apetro	4	4	4	4	4	4	4	4	4
21		flab	achem	4	4	4	4	4	4	4	4	4
22		flab	apharma	4	4	4	4	4	4	4	4	4
23		flab	aotr_mfg	4	4	4	4	4	4	4	4	4
24		flab	ametal	4	4	4	4	4	4	4	4	4
25		flab	atransp	4	4	4	4	4	4	4	4	4
26		flab	aelec	4	4	4	4	4	4	4	4	4
27		flab	agas_dst	4	4	4	4	4	4	4	4	4
28		flab	aconstr	4	4	4	4	4	4	4	4	4
29		flab	atrnsp	4	4	4	4	4	4	4	4	4
30		flab	atr_d_svc	4	4	4	4	4	4	4	4	4
31		flab	aotr_svc	4	4	4	4	4	4	4	4	4
32		flab	afin_svc	4	4	4	4	4	4	4	4	4
33												
34												
35												

The determination of appropriate elasticities is the responsibility of the user; the numbers in the model template are placeholders **only**.

#### 7.2.4 Linear Expenditure System Elasticities

The elasticities of substitution used for the linear expenditure systems (LES) are only supplied from Excel, and require the user to provide both income elasticities of demand and Frisch elasticities. The income elasticities of demand are recorded in the worksheet ‘incelast’ and supply data for the model parameter *ELASTY*; this table make be slightly confusing because of the additional column of labels – “hous” – but since there is only a single household in each region for the GTAP model this is only included for model convenience and (future) flexibility. Except for the additional column of identifiers for this table, *ELASTY*, is identical to those for commodities and activities see Figure7.2.4.1. The determination of appropriate elasticities is the responsibility of the user; the numbers in the model template are placeholders **only**.

Figure 7.2.4.1 Income Elasticity for GLOBE

	A	B	C	D	E	F	G	H	I	J	K	L
1	<b>Model Specific Household Income Elasticities</b>											
2	Elasticities											
3												
4	ELASTY	ELASTY	ELASTY									
5				w_Afr	N_Afr	E_Afr	SACU	Othr_Asia	Othr_S_A	C_Amer	Othr_L_A	Brazil
6		ograin	hous	1	1	1	1	1	1	1	1	1
7		cothr_ag	hous	1	1	1	1	1	1	1	1	1
8		coilseed	hous	1	1	1	1	1	1	1	1	1
9		clvstk	hous	1	1	1	1	1	1	1	1	1
10		ccoal	hous	1	1	1	1	1	1	1	1	1
11		coil_ext	hous	1	1	1	1	1	1	1	1	1
12		cgas_ext	hous	1	1	1	1	1	1	1	1	1
13		cmine	hous	1	1	1	1	1	1	1	1	1
14		cmeat	hous	1	1	1	1	1	1	1	1	1
15		cv_oil	hous	1	1	1	1	1	1	1	1	1
16		cothr_foo	hous	1	1	1	1	1	1	1	1	1
17		ctext	hous	1	1	1	1	1	1	1	1	1
18		cleath	hous	1	1	1	1	1	1	1	1	1
19		cwood	hous	1	1	1	1	1	1	1	1	1
20		cpetro	hous	1	1	1	1	1	1	1	1	1
21		cchem	hous	1	1	1	1	1	1	1	1	1
22		cpharma	hous	1	1	1	1	1	1	1	1	1
23		cothr_mfg	hous	1	1	1	1	1	1	1	1	1
24		cmetal	hous	1	1	1	1	1	1	1	1	1
25		ctransp	hous	1	1	1	1	1	1	1	1	1
26		celec	hous	1	1	1	1	1	1	1	1	1
27		cgas_dst	hous	1	1	1	1	1	1	1	1	1
28		cconstr	hous	1	1	1	1	1	1	1	1	1
29		ctrnsp	hous	1	1	1	1	1	1	1	1	1
30		ctrd_svc	hous	1	1	1	1	1	1	1	1	1
31		cothr_svc	hous	1	1	1	1	1	1	1	1	1
32		cfir_svc	hous	1	1	1	1	1	1	1	1	1
33												

The Frisch elasticities are recorded in the worksheet ‘frischelast’ and supply data for the model parameter *ELASTF*; note how these elasticities are defined by region and household; the worksheet ‘frischelast’ is shown in Figure 7.2.4.2. The determination of appropriate elasticities is the responsibility of the user; the numbers in the model template are placeholders **only**.

The default values for *ELASTY* are all one and the default values for *ELASTF* are all minus one. This is a special case whereby the LES utility functions reduce to Cobb-Douglas utility functions for all regions.

**Figure 7.2.4.2 Frisch Elasticities for GLOBE**

	A	B	C	D	E	F	G
1	<b>Model Specific Household Elasticities</b>						
2	Elasticities						
3							
4	ELASTF	ELASTF	ELASTF				
5			hous				
6		W_Afr	-1				
7		N_Afr	-1				
8		E_Afr	-1				
9		SACU	-1				
10		Othr_Asia	-1				
11		Othr_S_A	-1				
12		C_Amer	-1				
13		Othr_L_A	-1				
14		Brazil	-1				
15		China_Hk	-1				
16		Russ	-1				
17		India	-1				
18		Mid_East	-1				
19		Othr_Eur	-1				
20		Fmr_SU	-1				
21		Aus_Nzl	-1				
22		NAFTA	-1				
23		EU_27	-1				
24		H_Asia	-1				
25		Glb	-1				
26							

7.3 Worksheets to define nested production structure

The user creates a production nesting structure first by adding aggregate factors to the set *sac*, and the subsets *ff(sac)* and *fag(sac)*. There are a number of excel sheets used to assign the factors and factor aggregates at each level of the nest.

7.3.1 Value Added Nest

The user assigns the factors and/or aggregate factors that are in the value added nest in the worksheet 'nest\_va'. There is mapping between *ff* and each activity, *a*, in the model. See Figure 7.3.1.1.

**Figure 7.3.1.1 Value Added Nest Worksheet**

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	<b>Sets for Production Nests</b>												
2													
3	map_va_ff(ff,a)												
4													
5			agrain	aothr_ag	aoilseed	alvstk	acoal	aoil_ext	agas_ext	amine	ameat	av_oil	aothr_fo
6		fcapen	1	1	1	1	1	1	1	1	1	1	1
7		flnd_nr	1	1	1	1	1	1	1	1	1	1	1
8		flab	1	1	1	1	1	1	1	1	1	1	1
9													
10													
11													

7.3.2 Aggregate Factor Nests

The user assigns the factors and/or aggregate factors that are in the factor aggregate nests in the worksheet 'nest\_fagg'. Each aggregate factor is mapped to the natural and/or aggregate factors with which it is nested. There is an assignment for each activity in the model. See Figure 7.3.2.1.

Figure 7.3.2.1 Aggregate Factor Nests Worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Sets for Production Nests														
2															
3	map_fagg_ff(ff,ff,a)														
4	Aggregates														
5			agrain	aothr_ag	aoilseed	alvstk	acoal	aoil_ext	agas_ext	amine	ameat	av_oil	aothr_fooc	atext	aleath
6	flnd_nr	fland	1	1	1	1	1	1	1	1	1	1	1	1	1
7	flnd_nr	fnres	1	1	1	1	1	1	1	1	1	1	1	1	1
8	flab	fsklab	1	1	1	1	1	1	1	1	1	1	1	1	1
9	flab	funsklab	1	1	1	1	1	1	1	1	1	1	1	1	1
10	fcapen	fcap	1	1	1	1	1	1	1	1	1	1	1	1	1
11	fcapen	fenerg	1	1	1	1	1	1	1	1	1	1	1	1	1
12	fenerg	fcelec	1	1	1	1	1	1	1	1	1	1	1	1	1
13	fenerg	felecn	1	1	1	1	1	1	1	1	1	1	1	1	1
14	felecn	fccoal	1	1	1	1	1	1	1	1	1	1	1	1	1
15	felecn	fcoil_ext	1	1	1	1	1	1	1	1	1	1	1	1	1
16	felecn	fcgas_ext	1	1	1	1	1	1	1	1	1	1	1	1	1
17	felecn	fcpetro	1	1	1	1	1	1	1	1	1	1	1	1	1
18	felecn	fcgas_dist	1	1	1	1	1	1	1	1	1	1	1	1	1
19															
20															
21															

7.3.3 Aggregate Factor to Natural Factors

All aggregate factors ultimately are composed of natural factors. The worksheet 'nest\_agg' has the mapping of all natural factors to the aggregate factors that use the natural factors by activity, *a*. See Figure 7.3.2.3.

**Figure 7.3.2.3 Natural Factors to Aggregate Factors Worksheet**

	A	B	C	D	E	F	G	H	I	J	K	L	
1	Sets for Production Nests												
2													
3	map_agg(ff,ff,a)												
4													
5			agrain	aotr_ag	aoilseed	alvstk	acoal	aoil_ext	agas_ext	amine	ameat	av_oil	aot
6	flnd_nr	fland	1	1	1	1	1	1	1	1	1	1	1
7	flnd_nr	fnres	1	1	1	1	1	1	1	1	1	1	1
8	flab	fsklab	1	1	1	1	1	1	1	1	1	1	1
9	flab	funsklab	1	1	1	1	1	1	1	1	1	1	1
10	fcapen	fcap	1	1	1	1	1	1	1	1	1	1	1
11	fcapen	fcccoal	1	1	1	1	1	1	1	1	1	1	1
12	fcapen	fcoil_ext	1	1	1	1	1	1	1	1	1	1	1
13	fcapen	fcgas_ext	1	1	1	1	1	1	1	1	1	1	1
14	fcapen	fcpetro	1	1	1	1	1	1	1	1	1	1	1
15	fcapen	fcelec	1	1	1	1	1	1	1	1	1	1	1
16	fcapen	fcgas_dist	1	1	1	1	1	1	1	1	1	1	1
17	fenerg	fcccoal	1	1	1	1	1	1	1	1	1	1	1
18	fenerg	fcoil_ext	1	1	1	1	1	1	1	1	1	1	1
19	fenerg	fcgas_ext	1	1	1	1	1	1	1	1	1	1	1
20	fenerg	fcpetro	1	1	1	1	1	1	1	1	1	1	1
21	fenerg	fcelec	1	1	1	1	1	1	1	1	1	1	1
22	fenerg	fcgas_dist	1	1	1	1	1	1	1	1	1	1	1
23	felecn	fcccoal	1	1	1	1	1	1	1	1	1	1	1
24	felecn	fcoil_ext	1	1	1	1	1	1	1	1	1	1	1
25	felecn	fcgas_ext	1	1	1	1	1	1	1	1	1	1	1
26	felecn	fcpetro	1	1	1	1	1	1	1	1	1	1	1
27	felecn	fcgas_dist	1	1	1	1	1	1	1	1	1	1	1
28													
29													

## 7.4 Controls Worksheet

There are numerous aspects of the model structure and the flow of the programme that the user might wish to control. The approach used in the GLOBE model is to concentrate as many of these aspects of the programme as practical in an Excel worksheet – the ‘controls’ worksheet. This has two tables of entries, the first, `mod_control`, contains a number of elements that pass parameters to the model that control aspects of model structure, while the second, `flow_control`, passes parameters to the model that are used to determine whether various IF statements are implemented, and hence whether certain non-crucial components of the programme run.

### 7.4.1 Model Controls

The `mod_control` parameters are contained in a data table that consists of various elements – Figure 7.4.1.1. Also included are examples of typical default values and brief descriptions of the role of each parameter in the configuration of the model.

Figure 7.4.1.1 Model Controls

	A	B	C	D	E
1	<b>Control Parameters</b>				
2	<b>These values are used to initialise various parameters that condition the model and control th</b>				
3					
4					
5	<b>mod_control</b>				
6					
7	<b>mcons</b>				
8	numerchk	1			IF 1 then default, if NOT 1 then check on numeraire
9	mintrans	0.00001			Minimum values for transactions in unscaled SAMG
10	minaqxsh	0.1			Minimum share of intermediates in cost for aq
11	samscale	0.001			SAM scaling factor and initial value for autoscaling
12	scaltarget	100			target level for auto scaling
13	scalprop	0.95			proportion of NON zero elements that must be below the target level
14	armelast	2			IF 1 then ALL Armington elasticities from Excel; IF 2 ALL from 'GTAP'
15	armscal	2			Scaling value for GTAP Armington elasticities - divided by armscal
16	cetelast	2			IF 1 then ALL CET elasticities from Excel; IF 2 ALL from 'GTAP'
17	cetscal	2			Scaling value for GTAP CET elasticities - divided by cetscal
18	qxelast	2			IF 1 then ALL Level 1 production elasticities from Excel; IF 2 ALL from 'GTAP'
19	qxscal	2			Scaling value for GTAP Level 1 Production elasticities - divided by qxscal
20	qvaelast	2			IF 1 then ALL Level 2 production elasticities from Excel; IF 2 ALL from 'GTAP'
21	toldiffsam	0.00001			Tolerance level for differences between data and solution SAMs
22					

The parameters in lines 14 to 20 (inclusive) are of particular importance. These parameters determine which elasticities are used to calibrate the model; if *armelast*, *cetelast*, *qcelast* and *qvaelast* are equal to 1 then the respective elasticities come from Excel whereas if they are equal to 2 the respective elasticities come from GDX. The *mod\_control* parameter also allows the user the scale any elasticities taken from GTAP using uniform scaling parameters *armscal*, *cetscal* and *qxscal*.

## 7.5 Layout Worksheet

The syntax for the 'layout' worksheet is described in the.gdx utilities documentation supplied with GAMS. Unless the user wants to pass ADDITIONAL sets and data to the model there is no reason for the user to alter the 'layout' worksheet. If changes are made to the structure of the database it is important to ensure that all the syntax etc., is fully consistent; this is especially the case when working with GDXXRW since the error messages are not always as informative as the user might wish. If the user does get errors then it is wise to review the associated \*.log file since the detail therein is the most comprehensive available.

Figure 7.5.1 Data 'Layout' Worksheet

1	A	B	C	D	E	F	G	H
2	<b>LAYOUT</b>							
3	<b>Data Typ</b>	<b>Name</b>	<b>Location</b>	<b>Row dim</b>	<b>Column</b>	<b>Total dimension</b>		
4				rdim	cdim	dim		
5								
6	dset	sac	sets!A5		1			
7	dset	r	sets!D5		1			
8	dset	ref	sets!G5		1			
9	dset	c	sets!I5		1			
10	dset	oagr	sets!J5		1			
11	dset	onot	sets!K5		1			
12	dset	ofd	sets!L5		1			
13	dset	oind	sets!M5		1			
14	dset	cuti	sets!N5		1			
15	dset	oser	sets!O5		1			
16	dset	oagg	sets!P5		1			
17	dset	a	sets!Q5		1			
18	dset	aagr	sets!R5		1			
19	dset	anat	sets!S5		1			
20	dset	afd	sets!T5		1			
21	dset	aing	sets!U5		1			
22	dset	auti	sets!V5		1			
23	dset	aser	sets!W5		1			
24	dset	aagg	sets!X5		1			
25	dset	f	sets!Y5		1			
26	dset	l	sets!Z5		1			
27	dset	ls	sets!AA5		1			
28	dset	lu	sets!AB5		1			
29	dset	k	sets!AC5		1			
30	dset	lnd	sets!AD5		1			
31	dset	h	sets!AE5		1			
32	dset	tmr	sets!AF5		1			
33	dset	ter	sets!AG5		1			
34	dset	tff	sets!AH5		1			
35	dset	g	sets!AI5		1			
36	dset	i	sets!AJ5		1			
37	dset	owatpmarg	sets!AK5		1			
38	dset	w	sets!AL5		1			
39	dset	aleon	mod_sets!A5		1			
40	dset	rleon	mod_sets!B5		1			
41	set	map_w_tmr	maps!A5		2			
42	set	map_tmr_w	maps!D5		2			

DR

## 8. Model Calibration Checks

The ANARRES model has several aspects that facilitate checking that the model is correctly specified. Whenever the user makes any changes to the model or the model data these checks should be conducted BEFORE carrying out any simulations; failure to do so may mean that the simulations are conducted using an incorrectly specified model.

1. Slack variables: All the slack variables should equal zero, or very nearly zero. Search for 'var walras, 'var kapwor\_sl', 'var glb\_sl\_m' – all should be zero. (Note: if the version of GAMS used has indexing for the list file select SolVar and the slacks are reported at the end of the list of variables.)
2. Check the Left-hand sides: Search for 'LHS', then after finding the first occurrence of 'LHS' search for '\*\*\*'. If any equations are incorrectly specified, they are identified. (Note: if the version of GAMS used has indexing for the list file select SOLEQU and then the first named equation, this will move the cursor to the first equation.)
3. Check data replication: First check the Macro SAM: search for 'ASAMG2CHK' – all the values should equal 1; then search for and check DIFFASAMG2 and CNTASAMG2 – these should be zeros or close to zero. Second check the Micro SAM: search for and check DIFFSAMG2 and CNTSAMG2 – these should be zeros or close to zero. (Note: if the version of GAMS used has indexing for the list file select DISPLAY.)
4. Check the numéraire: The Excel workbook go to the worksheet 'mcontrols' and change the value of 'numerchk' to 2, save the Excel file and rerun the model. Then check the Macro SAM: search for 'ASAMG2CHK' – all the values should equal 2; note that DIFFASAMG2 and CNTASAMG2 are no longer meaningful and therefore the micro SAM calculations have not been implemented.

If the model passes all these checks the model will (usually) be correct.

## 9. Developing ‘Meaningful’ Global CGE Experiments

The interpretation of the term ‘meaningful’ CGE experiments depends on the understanding of the role of the analyst: specifically, the extent to which the analyst’s role is to provide advice about policy options and/or exogenous shocks. The understanding adopted here is that the analyst’s role is to assess policy options and/or exogenous shocks, identify the implications of different policy options and/or exogenous shocks and provide information about the policy responses available to decision makers. It is assumed that the analyst role is not to legitimise policy decisions already made; in which cases the analyst’s role is to provide impartial information about the implications of those decisions.

At the heart of this understanding is the perspective that CGE models represent ‘laboratories’ within which controlled economic experiments can be conducted, and the relationships between policy options and/or exogenous shocks and policy responses can be explored. Moreover, CGE models are analytic not forecasting models. The results from policy experiments are not forecasts of outcomes because the method analyses the implications of policy options and/or exogenous shocks assuming other aspects of the economic system do not change.<sup>20</sup> A strength of CGE analyses lies in their ability to analyse the implications of shocks in the economic environment that cause changes in the economic relationships found in previous periods.

In conducting analyses, it is important to avoid falling into the traps of logical fallacy. There are three fallacies that it is especially important to avoid:

1. ‘*post hoc ergo propter hoc*’ (after this because of this), e.g., assuming a change in agricultural policy cause a change in productivity when there was a change in the weather;
2. argument by analogy, e.g., it worked in country A so it will work in country B; and
3. appeal to authority, e.g., an international authority/organisations says this is the best policy choice.

Finally, this section assumes that before embarking on CGE analyses analysts have critically evaluated whether CGE methods are appropriate for the issue under investigation,

---

<sup>20</sup> Typically, economic forecasting models depend on statistical inference with the implicit presumption that past statistical relationships are maintained in the future.

e.g., are partial equilibrium tools adequate, would econometric methods provide better insights, are empirical methods appropriate, etc.

### 'Backstory'

All economic analyses depend on an understanding of the economy and policy issue being examined. Consequently, a fundamental requirement before conducting CGE analyses is the development of the 'backstory'. Simplistically this can be considered under four headings: what is the economic structure of the economy; how does the economy operate; what is the socio-political-economic environment; and what are the policy issues and/or exogenous shocks being examined. These considerations are not independent but for expositional ease they will be addressed individually.

How economies react to changes depends substantially upon the structure the economy, both in terms of the natural and human resources available, e.g., oil price changes impact differently on importers and exporters, technology, e.g., the cost functions of activities, and preferences, e.g., expenditures patterns by different institutions. Most of this information is provided to CGE models from the Social Accounting Matrix (SAM), which suggests that this step is largely mechanical; but it is important that the analyst knows enough about the economy to evaluate the extent to which the SAM accurately reflects the reality of the economy. Understanding the economic structure of an economy will be important for the interpretation of the policy experiments.

Economies may have similar structures but operate in different ways, e.g., command and 'free-market' economies may respond differently to changes. So, it is important to understand the various dimensions of how an economy operates, e.g., what is the exchange rate regime, what are the tax system options, etc. This relates closely to the socio-political-economic environment, which may strongly influence the range of responses open to decision makers, e.g., to what extent can decision-makers respond to adverse policy shocks by reducing current consumption while maintaining investment. It is also important to recognise that seemingly rational economic responses may be political unviable, e.g., rapid and sharp rises in food prices, and/or uneconomic, e.g., the implementation of seemingly optimal tax instruments may not be cost effect given the economic structure.

Finally, economic policy decisions are not abstract decisions; they take place within the broader context of the socio-political-economic environment. It is therefore important that the

analyst is familiar with and understands the limitations on the policy space in which decision makers operate; otherwise the policy response explored may not be feasible. This requires the development of an understanding of the current policy environment. This does not mean that the analyst should not explore policy responses that may be ‘politically’ contentious; rather it means the analyst needs to recognise how decision makers may react to the results from the analyses.

### Simulations and Experiments

This may seem to be a trivial distinction since CGE analysts often use the terms ‘simulations’ and ‘experiments’ interchangeably.<sup>21</sup> One interpretation of ‘simulations’ is that they simulate specific shocks, e.g., specific changes trade taxes mandated by decision makers; as such they seek to simulate pre-determined policy changes, which contradicts the assertion that “the analyst’s role is to provide advice about policy options and/or exogenous shocks”. On the other hand, one interpretation of ‘experiments’ is that they evaluate the implications of a range of shocks, e.g., a range of different changes trade taxes, as such the analysts can advise the decision makers about the implications of different shocks: this is consistent with the assertion that “the analyst’s role is to provide advice about policy options and/or exogenous shocks”.

In the real-world decision makers may not be interested in information about different shocks because such information may contradict the political decisions; so often there is a ‘tight rope’ to walk.

### *Policy Issues*

The formulation of appropriate experiments requires an understanding of the policy environment within which decisions may need to be taken.

### *Closure Settings*

Divide between the two categories

#### *Macroeconomic Closures*

How the macroeconomy operates

#### *Factor Market Clearing Conditions*

---

<sup>21</sup> This is not aided by the fact that the GLOBE and STAGE models use the set ‘sim’.

*ANARRES: A User Guide*

Long run vv short run; surplus factors

### Comparative Statics

### Sensitivity Analyses

Unknown exogenous data

### Analysing Results

Explanation not simple reporting of summary results

DRAFT

## 10. Experiment File Template

The experiment file is where the user has to be most active. The model file is largely straightforward and any changes the user would make are standardised, but the range of potential changes in the experiment file are very large and defy standardisation.

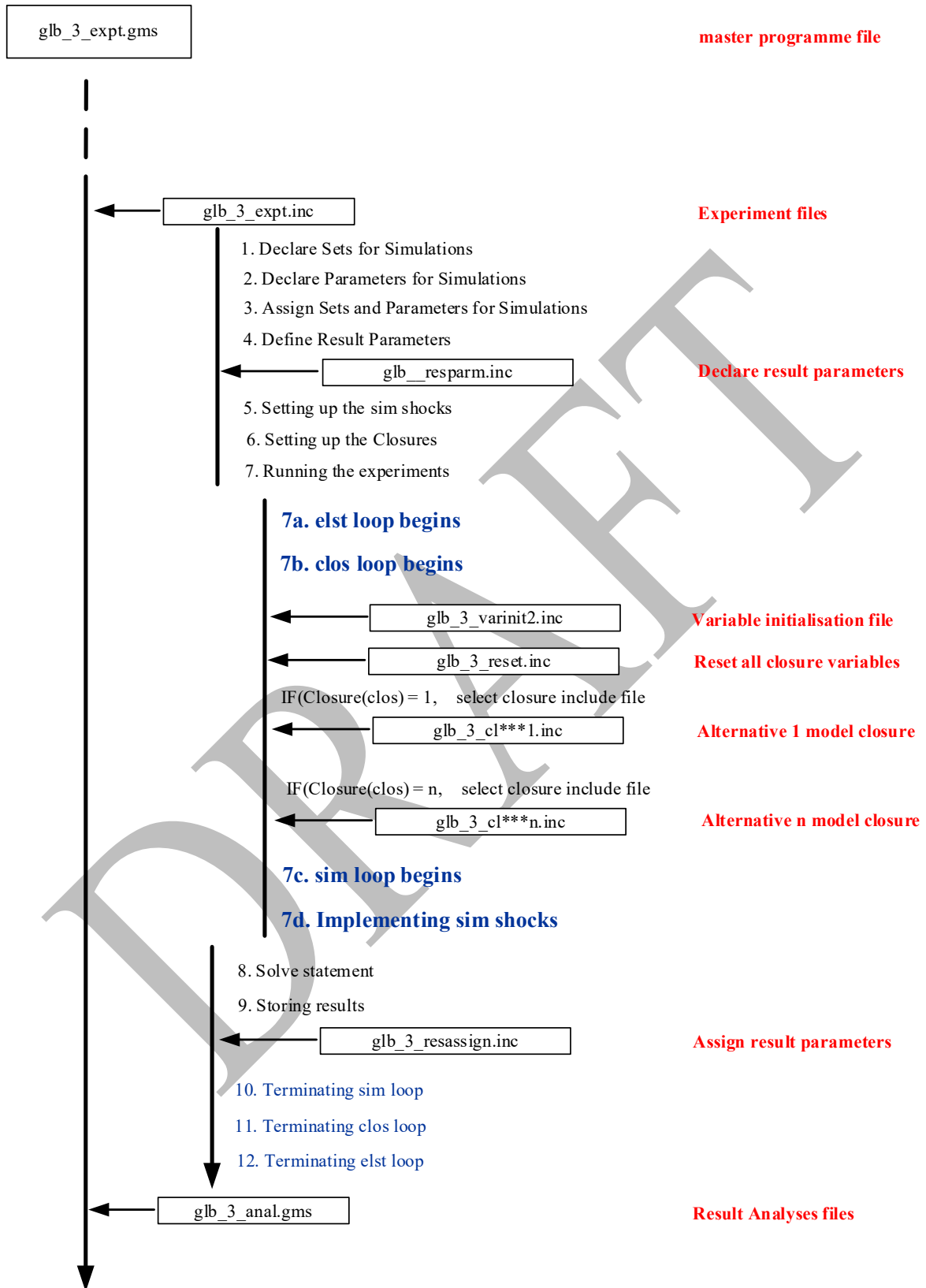
### 9.1 Experiment File Structure

The structure of the experiment file is illustrated in Figure 9.1.1.

The experiment file is set up so that a set of simulations are run in a LOOP that is nested within 2 other the LOOPS; the first allows the user to change the closure conditions while the other allows the user to change the elasticities. All the LOOPS have controlling sets that can be multi or single member sets – *sim* for simulations, *clos* for closure and *elst* for elasticities. When changing closure conditions, it is necessary to reset the choice of ‘fixed’ variables; this is done for ALL variables that can enter into any closure condition by the file `glb1_reset.inc`.

With the completion of each simulation the levels values for the results are assigned to the appropriate results parameter – all results parameters use the same name as the associated variable prefixed with ‘res’. These levels results are subsequently used to derived additional (analytical) results (see below).

**Figure 9.1.1 ANARRES Experiment File Structure**



## 11. Compiling an Experiment Excel Workbook

Despite the proliferation of files that arises from the use of a separate Excel workbook to contain sets and data used by each experiment there are substantial advantages. First, each worksheet with sets and data for an experiment can be related to a single experiment file, thereby assisting with replicability. Second, it facilitates programming of the experiment files by increasing the amount of generic code that can be used. And third, this approach allows the user to exploit the `save` and `restart` facility in GAMS while retaining the advantages of passing set and data information to the experiment files from Excel; this can provide appreciable savings in time when building up a series of simulations.

The arrangement of the Excel workbooks for experiments is essentially the same as for the model data; a series of worksheets containing structured information together with a ‘layout’ worksheet that provides an ‘index’. Note that the model is not designed so that changes in the behavioural structure can be affected during the experiment stage, except for changes to the series of closure rules.

### 10.1 Sets

#### *10.1.1 Simulation Sets*

The worksheet for the simulation sets, ‘simsets’, contains only generic simulation sets; these are sets that are declared as standard in the model code. These sets are

- `sim`      simulations set
- `simc`     current simulations run set
- `simr`     reported simulations set
- `elst`     elasticities set
- `clos`     closures set

Changing the membership of these sets allows for the running of different combinations of shocks, through ‘`simc`’, elasticities, through ‘`elst`’, and closures, through ‘`clos`’ without having to entry the specific choices directly in the experiment file.

**Figure 10.1.1.1 Simulations Sets Worksheet Part 1**

Simulations set		Applied Simulations set		Reported Simulations set	
sim	(description)	sim1	(description)	sim2	(description)
base	base simulation	base	base simulation	base	base simulation
sim02	remove EU27 export taxes	sim02	remove EU27 export taxes	sim02	remove EU27 export taxes
sim03a	half remove EU27 Import duties	sim03a	half remove EU27 Import duties	sim03	remove EU27 Import duties
sim03	remove EU27 Import duties	sim03	remove EU27 Import duties	sim04	remove EU27 trade taxes
sim04	remove EU27 trade taxes	sim04	remove EU27 trade taxes	sim05	common EU27 Average trade taxes
sim05	common EU27 Average trade taxes	sim05	common EU27 Average trade taxes	sim07	common EU27 Average factor use taxes
sim06	common EU27 Exogenous trade taxes	sim06	common EU27 Exogenous trade taxes	sim09	EU27 harmonisation on Average tax rates
sim07a	half common EU27 Average factor use taxes	sim07a	half common EU27 Average factor use taxes		
sim07	common EU27 Average factor use taxes	sim07	common EU27 Average factor use taxes		
sim08	common EU27 Exogenous factor use taxes	sim08	common EU27 Exogenous factor use taxes		
sim09a	part EU27 harmonisation on Average tax rates	sim09a	part EU27 harmonisation on Average tax rates		
sim09	EU27 harmonisation on Average tax rates	sim09	EU27 harmonisation on Average tax rates		
sim10	EU27 harmonisation on Exogenous tax rates				

The set ‘sim2’ is included to avoid reporting the results from intermediate steps. For some simulations using some aggregations it may be necessary to use a number of intermediate steps in order to achieve a solution and the user would typically not wish to consider the results from the intermediate steps.<sup>22</sup> In addition when using SeeResults to access the results it is relatively easy to overfill the pivot cache (max 60,000 observations).

**Figure 10.1.1.2 Simulations Sets Worksheet Part 2**

Closures set		Elasticities set	
clos	(description)	elst	(description)
clbase	Balanced macro closure	elst01	base elasticities
clos02	IPTS long run closure full emptyt		
clos03	IPTS long run closure umemptyt		
clos04	IPTS short run closure umemptyt		

In addition to the *sim* sets closure (*clos*) and elasticity (*elst*) sets are assigned to control the other LOOPS in the experiment file – see Figure 10.1.1.2.

### 10.1.2 Experiment Sets

GAMS is a set-based language and hence much of its power and flexibility comes from the use of sets. When defining experiments, it is often extremely useful to create (sub)sets to

<sup>22</sup> Experience suggests that for models with less than some 70,000 variables there are relatively few instances where a solution is not achieved relatively quickly, i.e., less than about 100 iterations, even when the shock is substantial.

abbreviate the coding of the shocks; the sheet ‘expsets’ exists for this purpose. This approach requires the user to declare the set in the experiment file, assign the set in Excel and extend the layout/index sheet to include the new set and then load the set using GDXIN. Some users prefer to declare AND assign sets directly in the experiment file. Both methods achieve the same objective.

**Figure 10.1.2 Experiment Sets**

Experiment file sets		renew		reu25	(description)	reu25n	(description)
<b>This file contains specific sets created to run particular experiments</b>							
deu	Germany	pol	Poland	deu	Germany	robu	Romania and Bugaria
ita	Italy	hun	Hungary	ita	Italy	tur	Turkey
aut	Austria	cze	Czech Republic	aut	Austria	roecd	Rest of the OECD
gbr	United Kingdom	reur	Rest of EU 25	gbr	United Kingdom	cis	Former communist block
fra	France			fra	France	merc	MERCUSOR
bnl	Benelux			bnl	Benelux	row	Rest of the World
espt	Spain and Portugal			espt	Spain and Portugal	glo	Globe
reu	Rest of EU 15			reu	Rest of EU 15		
				pol	Poland		
				hun	Hungary		
				cze	Czech Republic		
				reur	Rest of EU 25		

10.2 Flow Controls

The flow controls in the worksheet ‘econtrols’ are included so that the user can select which components of the analyses file are implemented. These are simple 0 or 1 parameters used to trigger IF statements. Figure 10.2.1 provides a screen shot of the ‘econtrols’ worksheet as can be seen there are descriptions for each parameter.

**Figure 10.2.1 econtrols**

Control Parameters			
<b>These values are used to initialise various parameters that condition experiments using the GLOBE programme</b>			
<b>exp_control</b>			
<b>econs</b>			
reslevel	1	IF 1 then womod_reslevel runs; IF 0 then womod_reslevel does not run	
ressamg	0	IF 1 then womod_ressamg runs; IF 0 then womod_ressamg does not run	
resmacro	1	IF 1 then womod_resmacro runs; IF 0 then womod_resmacro does not run	
resstruct	1	IF 1 then womod_resstruct runs; IF 0 then womod_resstruct does not run	
reswelf	1	IF 1 then womod_reswelf runs; IF 0 then womod_reswelf does not run	
resindex	0	IF 1 then womod_resindex runs; IF 0 then womod_resindex does not run	
restaxstr	0	IF 1 then womod_restaxstr runs; IF 0 then womod_restaxstr does not run	
resperc	1	IF 1 then womod_resperc runs; IF 0 then womod_resperc does not run	
resbase	1	IF 1 then basis for comparative results are initial values; IF 2 then bases are from an experiment	

10.3 Data

For some experiments it is convenient to provide the values for the shocks from a table of data, an example of such a data table is provided in Figure 10.3.1. If a user chooses this method a parameter must be declared in the experiment file, assigned in the Excel worksheet, the layout/index sheet must be extended to include the new parameter and then the data loaded using GDXIN.

Figure 10.3.1 Experiment Data Sheet

The screenshot shows an Excel spreadsheet with the following structure:

- Row 1:** Title: Common External Tariff of EU15 and EU25 with Trade Partners in accordance with the Regional and Commodity Aggregation of ANEFIS, ad valorem in %
- Row 2:** Section header: EU15
- Row 3:** Blank row
- Row 4:** Blank row
- Row 5:** Column headers for EU15: cgran, cscob, coerp, cpbf, clstk, cmik, caprd, cmins, cmeat, cmprd, cvof, cdair, csu
- Row 6:** Data row for 'wdeu' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 7:** Data row for 'wita' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 8:** Data row for 'waut' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 9:** Data row for 'wgbr' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 10:** Data row for 'wfra' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 11:** Data row for 'wbnl' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 12:** Data row for 'wespt' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 13:** Data row for 'wreu' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 14:** Data row for 'wpol' with values: 11.656, 10.113, 0.984, 0, 33.506, 1.844, 0, 69.09, 16.814, 3.408, 41.365
- Row 15:** Data row for 'whun' with values: 6.642, 0, 2.686, 0, 16.129, 2.955, 0, 52.264, 14.134, 0.573, 29.953
- Row 16:** Data row for 'wce' with values: 3.763, 0, 0.758, 0, 50.422, 2.802, 0, 52.851, 11.972, 8.733, 44.389
- Row 17:** Data row for 'wreur' with values: 1.468, 63.055, 1.149, 0, 21.137, 1.249, 0, 35.94, 11.504, 3.578, 40.121
- Row 18:** Data row for 'wrobu' with values: 15.366, 2.057, 18.084, 0.204, 3.373, 7.091, 2.032, 30.062, 42.726, 10.192, 26.932
- Row 19:** Data row for 'wtur' with values: 31.866, 19.022, 19.46, 0, 3.776, 2.12, 0, 65.09, 72.894, 13.564, 84.425
- Row 20:** Data row for 'wroecd' with values: 17.616, 13.909, 11.108, 0.445, 1.958, 4.218, 0.353, 35.176, 50.065, 4.334, 34.186
- Row 21:** Data row for 'weis' with values: 55.272, 52.808, 16.304, 1.944, 1.897, 3.826, 1.936, 26.106, 28.241, 15.681, 23.847
- Row 22:** Data row for 'wmerc' with values: 10.863, 9.544, 7.445, 9.271, 5.342, 7.045, 4.729, 11.965, 14.517, 12.941, 19.203
- Row 23:** Data row for 'wrow' with values: 14.462, 30.776, 13.024, 5.597, 0.985, 8.143, 6.6, 15.121, 15.259, 15.785, 11.04
- Row 24:** Data row for 'wglo' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
- Row 25-29:** Blank rows
- Row 30:** Section header: EU25
- Row 31:** Column headers for EU25: cgran, cscob, coerp, cpbf, clstk, cmik, caprd, cmins, cmeat, cmprd, cvof, cdair, csu
- Row 32:** Data row for 'wdeu' with values: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

10.4 Layout Sheet

The syntax for the 'layout' worksheet is described in the gdx utilities documentation supplied with GAMS. When making changes it is important to ensure that all the syntax etc., is fully consistent; this is especially the case when working with GDXXRW since the error messages are not always as informative as the user might wish. If the user does get errors then it is wise to review the associated \*.log file since the detail therein is the most comprehensive available.

Figure 10.4.1 Experiment Layout/Index Sheet

LAYOUT							
	A	B	C	D	E	F	G
1	LAYOUT						
2							
3	Data Typ	Name	Location	Row dim	Column	Total dimension	
4				rdim	cdim	dim	
5							
6	dset	aleon	mod_sets!A5		1		
7	dset	rleon	mod_sets!B5		1		
8	dset	sim	simsets!A5		1		
9	dset	sim1	simsets!D5		1		
10	dset	elst	simsets!G5		1		
11	dset	clos	simsets!J5		1		
12	dset	closelem	simsets!M5		1		
13	dset	stab1	ressets!A5		1		
14	dset	stab2	ressets!D5		1		
15	dset	stab3	ressets!G5		1		
16	dset	stab4	ressets!J5		1		
17	dset	stab5	ressets!M5		1		
18	dset	refix	clsets!A5		1		
19	dset	rsavfix	clsets!D5		1		
20	dset	rinvshfix	clsets!G5		1		
21	dset	riadjfix	clsets!J5		1		
22	dset	rkappfix	clsets!M5		1		
23	dset	rluen	clsets!S5		1		
24	par	controls	controls!A4		1	1	
25	dset	mcons	controls!A7		1		
26	dset	fcons	controls!A31		1		
27	par	flow_cont	controls!A31		1		
28	par	mod_cont	controls!A7		1		
29	dset	reul5	expsets!A5		1		
30	dset	reunew	expsets!D5		1		

DRAFT

## 12. Market Clearing and Model Closure Rules

The model is programmed to provide a wide degree of flexibility for the user in the selection of market clearing and model (macroeconomic) closure rules. The supplied version of the model adopts the principle that the model will be calibrated using a default version of these rules, and thereafter the user selects one or more sets of the rules that are implemented in a system of LOOPS that are embedded in the experiment file. This allows the user to conduct the same set of simulations using a range of different market clearing and model closure rules; this can be viewed as fulfilling one or more of the following objectives:

- identifying the contributions of different components of the model to the overall results;
- exploring properties of the model;
- conducting sensitivity analyses with respect to the (exogenously) imposed assumptions about economic systems; and
- allowing for uncertainty about the nature of the market clearing or macroeconomic mechanisms.

For any given region there are a large number of different permutations for these ‘rules’ and the number of permutations increase ‘exponentially’ as the number of regions in the model increases. It is therefore important to be systematic in identifying the rules that are to apply for each region and to include checks in the model simulations to ensure that the chosen ‘rules’ and those actually applied.

The extracts of code reported below are taken from the template file for closure conditions; greater detail is provided in the technical document for the GLOBE model. At the top of the file a simple ‘table’ provides a basis for summarising the chosen closure conditions, i.e.,

```

$ontext
  glbl_cl_template_1.inc

```

	CONDITION	REGIONS
FEX	- Exchange rate fixed - KAPWOR fixed	rerfx rerfxn
Investment	- absorption share fixed	All
Government	- absorption share fixed - TYH flexible - Additive form	All All

## ANARRES: A User Guide

	- CAPGOV fixed	All
Factors	- Land sector - mobile & full	All
	- Capital - mobile & full	All
	- Unskilled labour - mobile & full	All
	- Skilled labour - mobile & full	All
Numeraire	- CPI	All
\$offtext		

Repeating this where the closure *INCLUDE* file enters the experiment file provides one way of documenting the model and experiment.

### 11.1 Foreign Exchange Closure

```

*## FOREIGN EXCHANGE MARKET CLOSURE
* fix world numeraire in which foreign transactions are valued
ERPI.FX          = ERPI0 * numerchk ;
* globe transactions are in the numeraire currency
ER.FX("glo")    = ERPI0 * numerchk;
* globes trade balance is zero by definition of tship and the fact
* that there is only one imported commodity
* In this MODEL the exchange rate for all regions EXCEPT GLO is fixed
* and the current account balance is the equilibrating variable.
* ER.FX(rgn)     = ER0(rgn) ;
ER.FX(rerfx)    = ER0(rerfx) ;
* alternatively the external balance is fixed for non-reference
countries
* KAPWOR.FX(rgn) = KAPWOR0(rgn) ;
KAPWOR.FX(rerfxn) = KAPWOR0(rerfxn) ;

```

### 11.2 Investment-Savings Closure

```

*## INVESTMENT-SAVINGS CLOSURE
* IF aggregate investment is determined by aggregate savings
* i.e., the model is savings driven, then fix SADJ and DSHH
* Typically the actual/model savings rates are NOT fixed directly
* SADJ controls multiplicative changes in savings rates
* SADJ.FX(r)    = SADJ0(r) ;
* DSHH controls additive changes in savings rates
* NB DSHH needs to be used in conjunction with shh01
DSHH.FX(r)     = DSHH0(r) ;
* ALTERNATIVELY the model is made investment driven and the investment
* scaling factor is fixed

```

- \* IADJ.FX(r) = IADJ0(r) ;
- \* OR the shares of domestic final demand of investment is fixed  
INVESTSH.FX(r) = INVESTSH0(r) ;
- \* OR the value of domestic investment can be fixed  
INVEST.FX(r) = INVEST0(r) ;
- \* Closure rule for Government savings is part of the Govt Closure Rules

### 11.3 Government Closure Rules

- \*## GOVT CLOSURE RULES
- \* IF ALL tax rates are fixed
- \* AND Government consumption expenditure is fixed
- \* Then the equilibrating variable is Government Savings
- \* Tax rate scaling factors
- \* T\*ADJ control multiplicative changes in tax rates  
TEADJ.FX(r) = TEADJ0(r) ;  
TMADJ.FX(r) = TMADJ0(r) ;  
TSADJ.FX(r) = TSADJ0(r) ;  
TXADJ.FX(r) = TXADJ0(r) ;  
TYFADJ.FX(r) = TYFADJ0(r) ;  
TYHADJ.FX(r) = TYHADJ0(r) ;  
TFADJ.FX(r) = TFADJ0(r) ;
- \* DT\* control additive changes in tax rates
- \* NB DT\* needs to be used in conjunction with t\*01  
DTE.FX(r) = DTE0(r) ;  
DTM.FX(r) = DTM0(r) ;  
DTS.FX(r) = DTS0(r) ;  
DTX.FX(r) = DTX0(r) ;  
DTYF.FX(r) = DTYF0(r) ;  
\* DTYH.FX(r) = DTYH0(r) ;  
DTF.FX(r) = DTF0(r) ;
- \* GOVERNMENT EXPENDITURE
- \* FIX volume  
QGDADJ.FX(r) = QGDADJ0(r) ;
- \* OR FIX nominal  
EG.FX(r) = EG0(r) ;
- \* OR FIX shares of final demand  
VGDSH.FX(r) = VGDSH0(r) ;
- \* GOVERNMENT SAVINGS
- \* OR the internal balance / Govt savings can be fixed  
KAPGOV.FX(r) = KAPGOV0(r) ;

11.4 Factor Market Closure

```

*## FACTOR MARKET CLOSURE

*# Basic Factor Market Closure
*$ontext

FS.FX(f,r)           = FS0(f,r) ;
WFDIST.FX(f,a,r)     = WFDIST0(f,a,r) ;
WF.LO(f,r)           = -inf ;
WF.UP(f,r)           = +inf ;

*$offtext

* # Alternative Factor Market Closure

$ontext

* This code allows for controlling individual factors

When changing factor market closure rules be careful to count how many
conditions you relax, i.e., unfix, and how many you fix.

TO MAKE A FACTOR ACTIVITY SPECIFIC AND FIXED
i) Unfix FS.FX("factor") and WFDIST.FX("factor",a)
ii) Fix FD.FX("factor",a) AND ONE WFDIST.FX("??",a)

TO ALLOW FOR AN UNEMPLOYED FACTOR
i) Unfix FS.FX("factor")
ii) Fix WF.FX("factor") AND FS.LO("factor") and FS.UP("factor")

TO CONTROL FACTOR USE BY ACTIVITY
Adapt the procedure for making a factor activity specific and fixed
by specifying the activities.

NB GAMS reads the programme files from the top and hence if a
condition is over written it is the last statement that determines the
models behaviour.
Hence, it is often convenient to specify a general case for all
factors and/or activities and then OVERWRITE the general case with the
conditions for the specific case.

$offtext

$ontext
The example below assumes that all factors for all regions and
activities are fully employed and mobile, EXCEPT for unskilled labour
in the subset of regions rluen (regions with unskilled labour supply
endogenously determined). Note membership of rluen is specified in the
Excel worksheet for the experiment.
$offtext
$ontext

FS.FX(lu,rluex)           = FS0(lu,rluex) ;
WFDIST.FX(lu,a,rluex)     = WFDIST0(lu,a,rluex) ;
WF.LO(lu,rluex)           = -inf ;
WF.UP(lu,rluex)           = +inf ;
* WFDIST.FX(lu,"aotserv",rluex) = WFDIST0(lu,"aotserv",rluex) ;
* FD.FX(lu,a,rluex)         = FDO(lu,a,rluex) ;
* WF.FX(lu,rluex)          = WFO(lu,rluex) ;

```

## ANARRES: A User Guide

```

* FS.LO(lu,rluex)           = -inf ;
* FS.UP(lu,rluex)           = +inf ;

*   FS.FX(lu,rluen)         = FS0(lu,rluen) ;
WFDIST.FX(lu,a,rluen)      = WFDIST0(lu,a,rluen) ;
*   WF.LO(lu,rluen)         = -inf ;
*   WF.UP(lu,rluen)         = +inf ;
* WFDIST.FX(lu,"aotserv",rluen) = WFDIST0(lu,"aotserv",rluen) ;
* FD.FX(lu,a,rluen)         = FDO(lu,a,rluen) ;
WF.FX(lu,rluen)            = WFO(lu,rluen) ;
FS.LO(lu,rluen)            = -inf ;
FS.UP(lu,rluen)            = +inf ;

   FS.FX(ls,r)              = FS0(ls,r) ;
WFDIST.FX(ls,a,r)          = WFDIST0(ls,a,r) ;
WF.LO(ls,r)                = -inf ;
WF.UP(ls,r)                = +inf ;
* WFDIST.FX(ls,"aotserv",r) = WFDIST0(ls,"aotserv",r) ;
* FD.FX(ls,a,r)            = FDO(ls,a,r) ;
* WF.FX(ls,r)              = WFO(ls,r) ;
* FS.LO(ls,r)              = -inf ;
* FS.UP(ls,r)              = +inf ;

   FS.FX(k,r)               = FS0(k,r) ;
WFDIST.FX(k,a,r)           = WFDIST0(k,a,r) ;
WF.LO(k,r)                 = -inf ;
WF.UP(k,r)                 = +inf ;
* WFDIST.FX(k,"aotserv",r) = WFDIST0(k,"aotserv",r) ;
* FD.FX(k,a,r)            = FDO(k,a,r) ;
* WF.FX(k,r)              = WFO(k,r) ;
* FS.LO(k,r)              = -inf ;
* FS.UP(k,r)              = +inf ;

   FS.FX(lnd,r)             = FS0(lnd,r) ;
WFDIST.FX(lnd,a,r)         = WFDIST0(lnd,a,r) ;
WF.LO(lnd,r)               = -inf ;
WF.UP(lnd,r)               = +inf ;
* WFDIST.FX(lnd,"aagr",r)  = WFDIST0(lnd,"aagr",r) ;
* FD.FX(lnd,a,r)          = FDO(lnd,a,r) ;
* WF.FX(lnd,r)            = WFO(lnd,r) ;
* FS.LO(lnd,r)            = -inf ;
* FS.UP(lnd,r)            = +inf ;

   FS.FX("NatRes",r)        = FS0("NatRes",r) ;
WFDIST.FX("NatRes",a,r)    = WFDIST0("NatRes",a,r) ;
WF.LO("NatRes",r)          = -inf ;
WF.UP("NatRes",r)          = +inf ;
* WFDIST.FX("NatRes","APUBL",r) = WFDIST0("NatRes","APUBL",r) ;
* FD.FX("NatRes",a,r)      = FDO("NatRes",a,r) ;
* WF.FX("NatRes",r)        = WFO("NatRes",r) ;
* FS.LO("NatRes",r)        = -inf ;
* FS.UP("NatRes",r)        = +inf ;

```

\$offtext

## 11.5 Technology Variables

```
* # Technology Closures for Factor Market
```

```
* NB SHIFT factors are fixed indirectly through the adjustment
variables
```

\* Technology for CES production functions for Level 1 of production nest

- \* To FIX ADX fix BOTH ADXADJ and DADX
- \* NB DADX needs to be used in conjunction with adx01

ADXADJ.FX(r) = ADXADJ0(r) ;  
DADX.FX(r) = DADX0(r) ;

\* Technology for CES aggregation functions for Level 2 of production nest

- \* To FIX ADVA fix BOTH ADVAADJ and DADVA
- \* NB DADVA needs to be used in conjunction with adva01

ADVAADJ.FX(r) = ADVAADJ0(r) ;  
DADVA.FX(r) = DADVA0(r) ;

\* Technology for factor activity and region specific factor efficiency

ADFD.FX(f, a, r) = ADFD0(f, a, r) ;

### 11.6 Miscellaneous Fixed Variables

### MISCELLANEOUS FIXED VARIABLES

- \* To use CPI as the numeraire fix CPI

CPI.FX(r) = CPI0(r)\*numerchk ;

- \* To fix the real exchange rate fix ER and PPI

\* PPI.FX(r) = PPI0(r)\*numerchk ;

### 13. Tax Rate Shocks

In order to assist the user the template experiment file comes complete with declaration statements for tax rate shocks, i.e.,

Parameter

\* Standard parameters for tax instrument shocks

TESIM( <i>c, w, r, sim</i> )	Export taxes on exported comm'y <i>c</i> from <i>r</i> to <i>w</i>
TMSIM( <i>w, c, r, sim</i> )	Tariff rates on imported comm'y <i>c</i> from <i>w</i> by <i>r</i>
TSSIM( <i>c, r, sim</i> )	Sales tax rate
TXSIM( <i>a, r, sim</i> )	Indirect tax rate
TYFSIM( <i>f, r, sim</i> )	Direct tax rate on factor income
TYHSIM( <i>h, r, sim</i> )	Direct tax rate on households
TFSIM( <i>f, a, r, sim</i> )	Tax rate on factor use

together with statements in the LOOP that set the tax rates equal to those in base case.

The user is free to choose any name for the parameter that carries information used to shock a parameter; as a matter of good practice it is advisable to choose a name that links to the parameter being shocked, e.g., *TMSIM* refers to the variable *TM*.

## 14. Technology Shocks

In order to assist the user the template experiment file comes complete with declaration statements for technology shocks, i.e.,

```
* Standard parameters for efficiency rate shocks
ADXSIM(a,r,sim)      Shift parameter for CES prodn fns for QX in r
ADVASIM(a,r,sim)    Shift parameter for CES prodn fns for QVA
ADFDSIM(f,a,r,sim)  Shift parameter for factor & activity efficiency
```

The user is free to choose any name for the parameter that carries information used to shock a parameter; as a matter of good practice it is advisable to choose a name that links to the parameter being shocked, e.g., *ADVASIM* refers to the variable *ADVA*.

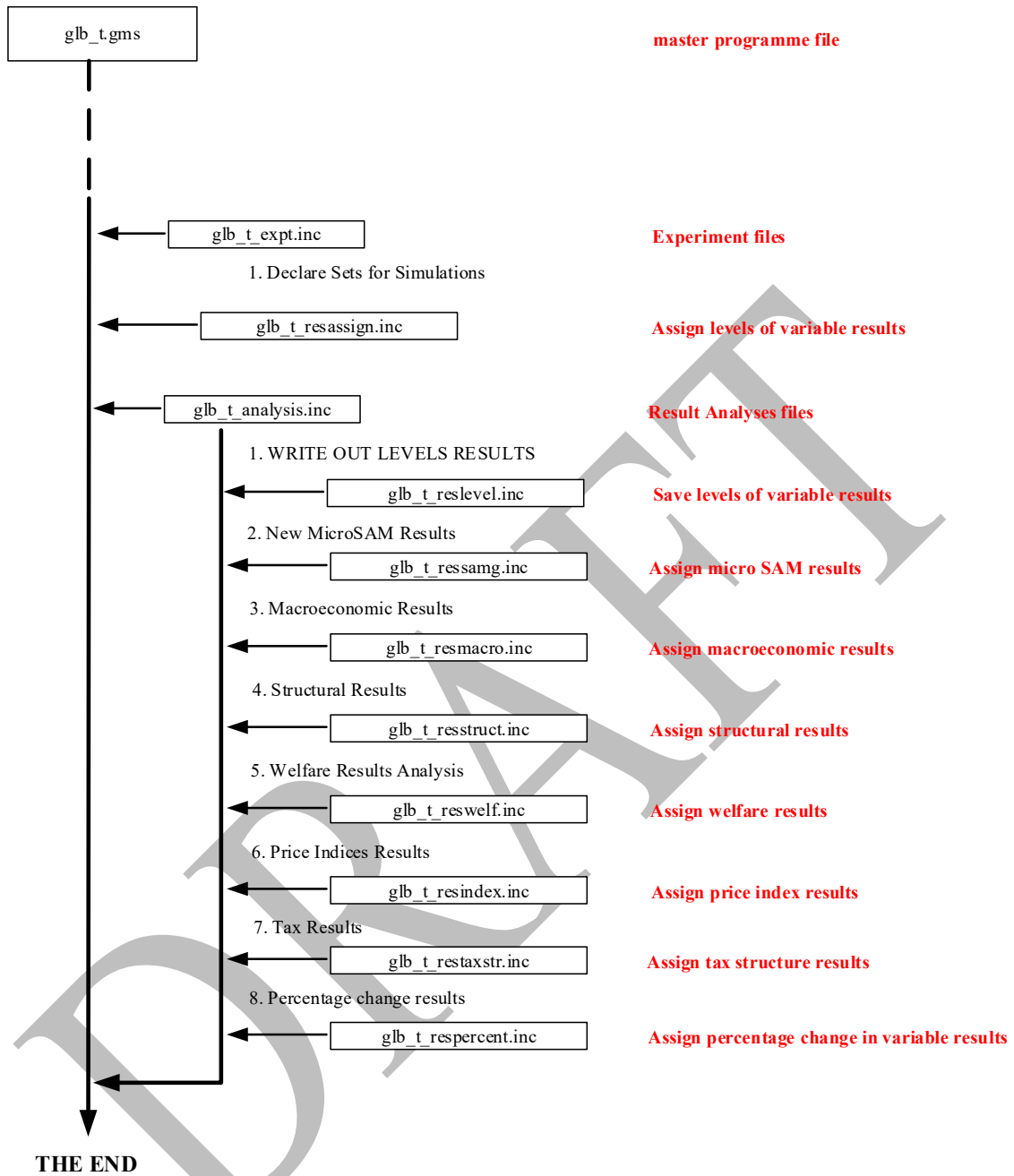
DRAFT

## 15. Analysis File

The analysis file uses the values for the variables after each solution plus the model's parameters to develop a series of derived results that assist in analyses of the model simulations. The various components of the analysis file are illustrated in Figure 14.1 and the user chooses which files to run by setting the 0/1 parameters in the worksheet 'econtrols'. Each component exports the results it generates to a GDX file with a default name linked to the name of the respective *INCLUDE* file; these can be changed but it is often easier to collect the GDX files containing the results together after a run (NB: if the GDX files are not collected and moved to another location/directory they will be over written).

DRAFT

**Figure 14.1 GLOBE Results Analysis File Structure**



The user should expect to extend the analyses files to meet the needs of the analyses they are engaged in conducting.

## **16. Changing the Model Database**

DRAFT

## **17. Fault Finding**

DRAFT

## References

- Francois, J.F. and Reinert, K.A. (ed) (1997). *Applied Methods for Trade Policy Analysis: A Handbook*. Cambridge: Cambridge University Press.
- King, B.B., (1985). 'What is a SAM?', in Pyatt, G. and Round, J.I. (ed), *Social Accounting Matrices: A Basis for Planning*. Washington: World Bank.
- McDonald, S. and Thierfelder, K., (2019). 'Deriving a Global Social Accounting Matrix and Satellite Data from GTAP Databases', cgemod Technical Paper 12, available at [www.cgemod.org.uk](http://www.cgemod.org.uk)
- McDonald, S. and Thierfelder, K., (2004). 'Deriving a Global Social Accounting Matrix from GTAP version 5 Data', *Global Trade Analysis Project Technical Paper 22*, 2004 Center for Global Trade Analysis: Purdue University.
- McDonald (2007). 'Deriving Reduced Form Global Social Accounting Matrices from GTAP Data'. *Mimeo*.
- McDonald, S. and Sonmez, Y., (2004). 'Augmenting the GTAP Database with Data on Inter-Regional Transactions', *Sheffield Economics Research Paper 2004:009*. The University of Sheffield.
- McDonald, S., (2007b). 'GLOBE-EN: GLOBE: Global CGE Energy Model', *mimeo* (with K Thierfelder).
- McDonald, S., (2007c). 'GLOBE-IC: Global CGE Model with Imperfect Competition', *mimeo*.
- PROVIDE (2004). 'SeeResults: A Spreadsheet Application for the Analysis of CGE Model Results', *PROVIDE Project Technical Paper 2004:1*. PROVIDE Project: Elsenburg.
- Pyatt, G. and Round, J.I. (1985) (ed), *Social Accounting Matrices: A Basis for Planning*. Washington: World Bank.
- Pyatt, G., (1991). 'Fundamentals of Social Accounting', *Economic Systems Research*, Vol 3, pp 315-341.
- Rutherford, T., (1998). GTAP6inGAMS, <http://www.mpsge.org/gtap6/>.
- Sadoulet, E. and de Janvry, A., (1995). *Quantitative Development Policy Analysis*. Baltimore: John Hopkins University Press.
- UN, (1993). *System of National Accounts 1993*. New York: UN.