



ANARRES v1: A User Guide (2012)

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Abstract

This is a user's guide to the ANARRES 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 implicitly 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 SeeResults. This User Guide does 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.

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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 details 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 and arranging data for the model and experiments.

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).

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 ANARRES

The structure of the ANARRES SAM is illustrated by means of a representative SAM for one region – the structure of the SAM for each and every region is identical. The description of the SAM structure is limited, since it is assumed that the reader is familiar with the basic principals 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 in light of 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.

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

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 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 into 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).¹ 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 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 1, while the actual numbers of accounts in each group of accounts are defined for version 5.4 and 6.0 of the GTAP database in Table 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

¹ 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.

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
Total		598	652	802	905
Total Number of Cells in the Global SAM		27,893,112	36,984,048	72,038,848	105,654,225

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,² 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 version³ of 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

² 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.

³ The term “version of ANARRES” is used to refer to an implementation of the ANARRES model with a specific aggregation of the database. A “version of ANARRES” is used to refer to an implementation of a version of the ANARRES model that contains either ‘limited’ or no variations in the behavioural relationships of the ANARRES model. More substantial changes in the ANARRES model are identified by ‘extending’ the ANARRES name, e.g., GLOBE-IC (McDonald, 2007b) is a version of ANARRES with imperfect competition and GLOBE-EN (McDonald and Thierfelder, 2007c) is a version of ANARRES to model energy use.

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.

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 and destination data files and then runs GAMS remotely from within the Excel programme⁴. 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).

$$\text{NEWSAM}(sp, spp, k) = \text{SUM}((ss, spp, kk) \\ \$ (\text{MAPSAMAG}(sp, ss))$$

⁴ The GAMS code at the heart of SAMgator is report in the Appendices.

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

The parameter $SAMG(ss,ssp,kk)$ contains the GTAP database where ss^5 is the set that defines the row and columns labels for the SAM for each of the kk regions. The parameter $NEWSAM(sp,spp,k)$ 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 $MAPSAMAG(sp,ss)$ defines the members of ss that aggregated into sp by the rows of $SAMG(ss,ssp,kk)$, while the set $MAPSAMAG(spp,ssp)$ defines the members of ssp that aggregated into ssp by the columns of $SAMG(ss,ssp,kk)$. (Note that there is only one mapping set $MAPSAMAG$ with its implementation being solely driven by the sets ss and s and their aliases.) The set $MAPREGAG(k,kk)$ 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.

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.⁶ 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

⁵ The set ssp is an alias for ss .

⁶ 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.

completion this is confirmation that Excel can trigger GAMS correctly and the user can press any key to continue.

Figure 3.1.1.1 Control Worksheet for SAMgator

Aggregation program for global SAM from GTAP data
This version also generates weighted averages of the GTAP elasticities ESUBD, ESUBM and ESUBVA. A correctly formulated input database is required.

Options:

GAMS.EXE location:

Pause after execution: ☒

.GDX file name

Input

Output

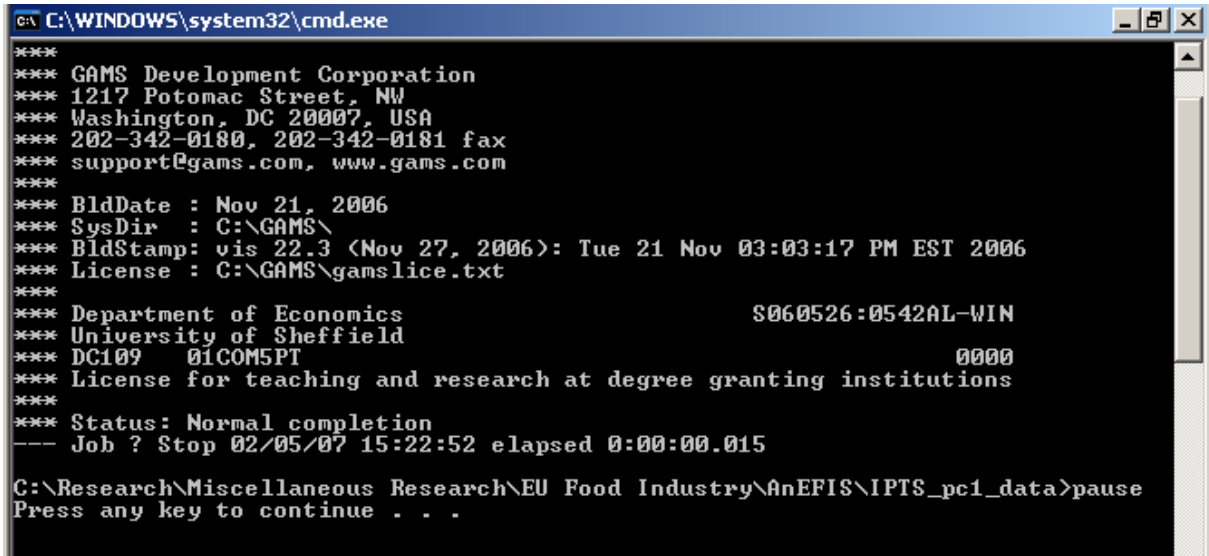
Aggregation program (.gms):

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'.⁷ 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

⁷ 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.

GAMS programme file; in this case 'globaggr_ipts1.gms'. The programme is not sensitive to the choice of naming conventions.

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:											
int_c - Commodities-Activiti int_f - Factors int_k - Regions vstmarg - export margin acc													Delete element Move Up Move Dn Edit Auto Sort	
													Name: Add Descr:	
Elements in input set mapped to selected element in output set:			Unmapped elements in input set:											
			<<< <- -> >>> 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 >se - Rest of Southeast Asia											

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.⁸
 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.

⁸ 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:											
int_c - Commodities-Activities int_f - Factors int_k - Regions vstmarg - export margin accounts			gran - Grains scb - Sugar cane and beet ocrp - Other crops pbf - Plant based fibres lstk - Livestock milk - Raw milk											
			Delete element Move Up Move Dn Edit Auto Sort Name: Add Descr:											
Elements in input set mapped to selected element in output set:			Unmapped elements in input set:											
pdr - Paddy rice wht - Wheat gro - Cereal grains nec			<<< <- -> >>>											

3.1.3 Sets

The worksheet sets provides a full listing of the set names and descriptions required by the GLOBE v1 model. These can be copied and pasted into the worksheet that contains set information for GLOBE v1.

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 aggregations⁹.

- 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 GILD region serves a special purpose in the ANARRES 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 ANARRES model.

⁹ 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 GLOBE model and three series of elasticities that are aggregates of the elasticities reported in the GTAP database. The parameters in the GDX database are:

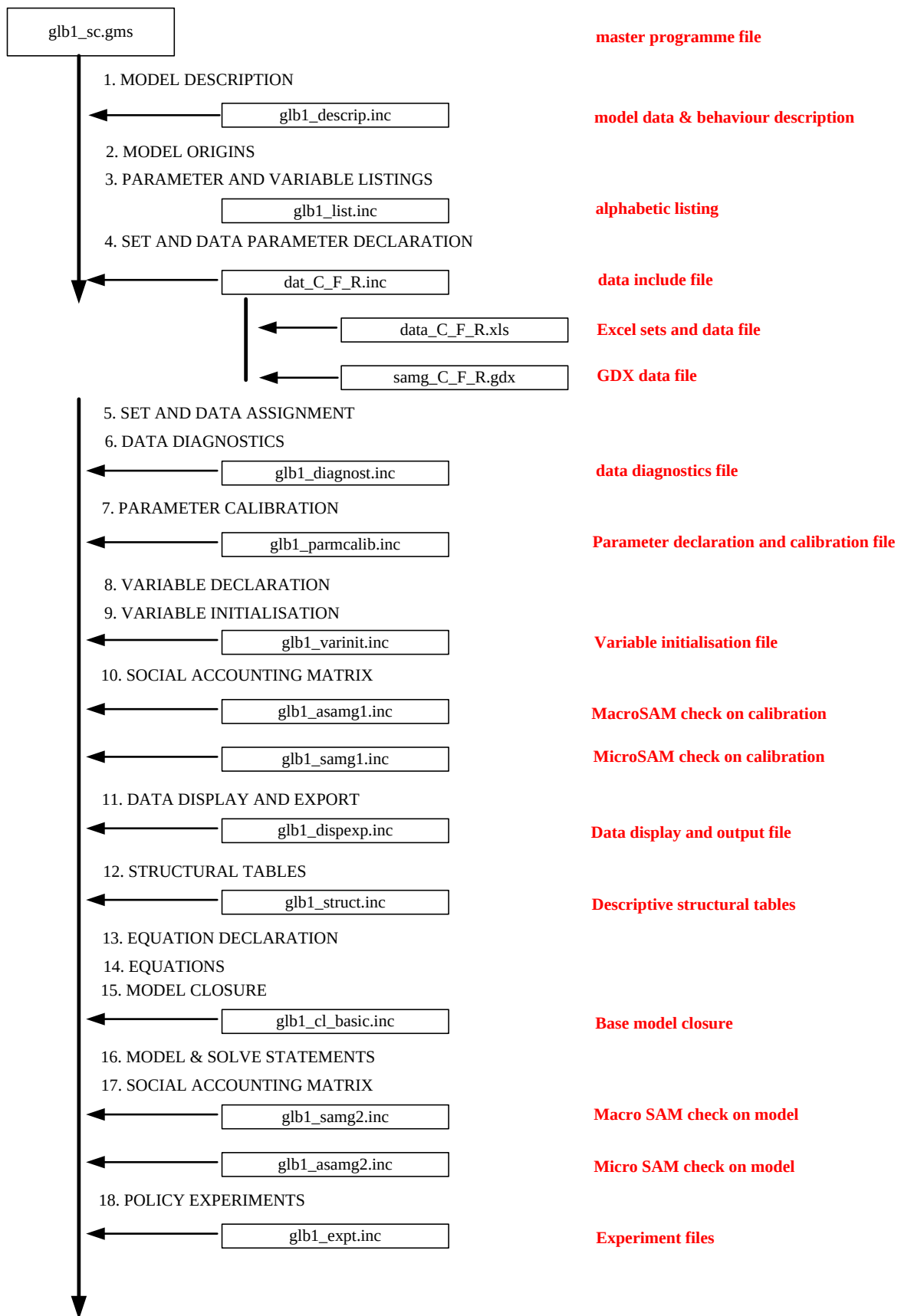
- NEWSAM – the aggregated global SAM in GLOBE format;
- ESUBD2 – Armington (CES) elasticities for level 1 domestic/(aggregate) import substitution, using domestic supply shares by value as weights;
- ESUBM2 – Armington (CES) elasticities for level 2 import substitution, using import supply shares by 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.

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 3 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 GLOBE File Structure

5.1 GLOBE Programme Structure

The schematic illustration of the structure of the ANARRES model file – `glb1_sc.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
- `glb1_expt.inc` – experiment file

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

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 GLO 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 SAMGF_C_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 `samscal` 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*.
- 5b. Defining sets to control homogenous exports

This uses the data and the sets *chomo1*, *chomo2*, *rhomo1* and *rhomo2* from the worksheet 'mod_sets' to set *cetn1* and *cetn2*. A manual option is also available.

7. Compiling the Model's Excel Workbook¹⁰

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. 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.

¹⁰ 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

A1		Sets							
	A	B	C	D	E	F	G	H	I
1	Sets								
2									
3	New SAM accounts						Regional Accounts for numeraire		Commodities
4	sac	(description)		r	(description)		ref		c
5	cgran	Grains		deu	Germany		deu		cgran
6	cscb	Sugar cane and beet		ita	Italy		ita		cscb
7	ccorp	Other crops		aut	Austria		aut		ccorp
8	cpbf	Plant based fibres		gbr	United Kingdom		gbr		cpbf
9	clstk	Livestock		fra	France		fra		clstk
10	cmilk	Raw milk		bnl	Benelux		bnl		cmilk
11	caprd	Other animal products		espt	Spain and Portugal		espt		caprd
12	cmins	Minerals		reu	Rest of EU 15		reu		cmins
13	cmeat	Meat		pol	Poland		reur		cmeat
14	cmprd	Meat products		hun	Hungary		roecd		cmprd
15	cvof	Vegetable oils and fats		cze	Czech Republic				cvof
16	cdair	Dairy products		reur	Rest of EU 25				cdair
17	csuga	Sugar		robu	Romania and Bugaria				csuga
18	cofd	Other food products		tur	Turkey				cofd
19	cbtob	Beverages and tobacco		roecd	Rest of the OECD				cbtob
20	cbind	Base industries		cis	Former communist block				cbind
21	cmanu	Manufactures		merc	MERCUSOR				cmanu
22	cmach	Machinery		row	Rest of the 'World				cmach
23	cutil	Utilities		glo	Globe				cutil
24	cons	Construction							cons
25	ctrd	Trade and communication							ctrd
26	ctran	Transport							ctran
27	cserv	Services							cserv
28	agran	Grains							
29	ascb	Sugar cane and beet							
30	acorp	Other crops							
31	apbf	Plant based fibres							
32	alstk	Livestock							
33	amilk	Raw milk							
34	aaprd	Other animal products							
35	amins	Minerals							

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 *glo*.

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
- *f(sac)* factor accounts
- *tmr(sac)* tariff accounts used in GDX program
- *ter(sac)* export subsidy accounts used in GDX program
- *tff(sac)* factor tax account used in GDX program
- *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
- *cfid(c)* Food commodities
- *cind(c)* Industrial commodities
- *cuti(c)* Utility commodities
- *cser(c)* Service commodities
- *aagr(a)* Agricultural activities
- *anat(a)* Natural resource activities
- *afid(a)* Food activities
- *aind(a)* Industrial activities
- *auti(a)* Utility activities
- *aser(a)* Service activities
- *l(f)* Labour Factors
- *ls(l)* Skilled Labour Factors
- *lu(l)* Unskilled Labour Factors
- *k(f)* 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* 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 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	P	Q	R	X	Y	Z	AE	AF	AG	AH	AI	AJ	AK	AL
1																
2																
3	Commodities	Agricultural Commodities	Commodity Aggregates	Activities	Agricultural Activities	Activity Aggregates	Factors	Labour Factors	Households	Import taxes	Export taxes	Taxes on Factors	Government	Savings/ Investment	all margins on imports	Rest of the world
4	c	cagr	cagg	a	aagr	aagg	f	l	h	tmr	ter	tff	g	i	owatpmarg	w
5	cgran	cgran	cagr	agran	agran	aagr	land	UnSkLab	HOUS	tmdeu	tedeu	tfland	SALTAX	KAP	owatpdeu	wdeu
6	csob	csob	onat	asob	asob	anat	UnSkLab	SkLab		tmita	teita	tfUnSkLab	PRODTAX		owatpita	wita
7	coerp	coerp	ofd	aocrp	aocrp	afd	SkLab			tmaut	teaut	tfSkLab	FACTAX		owatpaut	waut
8	cpbf	cpbf	cind	apbf	apbf	aind	cap			tmgbr	tegbr	tfcap	DIRTAX		owatpgr	wgr
9	clstk	clstk	cuti	alstk	alstk	auti	natres			tmfra	tefra	tfnatres	Govt		owatpfra	wfra
10	cmik	cmik	cser	amik	amik	aser				tmbnl	tebnl				owatpbnl	wbnl
11	caprd	caprd		aaprd	aaprd					tmespt	teespt				owatpespt	wespt
12	cmins			amins						tmreu	tereu				owatpreu	wreu
13	cmeat			ameat						tmpol	tepol				owatppol	wpol
14	cmprd			amprd						tmhun	tehun				owatphun	whun
15	cvoif			avof						tmcze	tecze				owatpcze	wcze
16	cdair			adair						tmreur	tereur				owatpreur	wreur
17	csuga			asuga						tmrobu	terobu				owatprobu	wrobu
18	cofd			aofd						tmur	teur				owatptur	wur
19	cbtob			abto						tmroed	teroed				owatproed	wroed
20	cbind			abind						tmcis	tecis				owatpcis	wcis
21	cmanu			amanu						tmmerc	temerc				owatpmmerc	wmerc
22	cmach			amach						tmrow	terow				owatprow	wrow
23	cutil			autil						tmglo	teglo				owatpglo	wglo
24	cens			acens												
25	etrd			atrd												
26	ctran			atran												
27	cserv			aserv												
28																
29																

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*.

Figure 7.1.2.1 Maps Worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Maps																
2																	
3																	
4	MAP V	TMR(w,tmr)	MAP TMR	w(tmr,w)	MAP V	TER(w,ter)	MAP TER	V(ter,w)	MAPR	V(r,w)	MAPV	R(w,r)					
5	wdeu	tmdeu	tmdeu	wdeu	wdeu	tedeu	tedeu	wdeu	deu	wdeu	wdeu	deu					
6	wita	tmita	tmita	wita	wita	teita	teita	wita	ita	wita	wita	ita					
7	waut	tmaut	tmaut	waut	waut	teaut	teaut	waut	aut	waut	waut	aut					
8	wgbr	tmgbr	tmgbr	wgbr	wgbr	tegr	tegr	wgbr	gbr	wgbr	wgbr	gbr					
9	wfra	tmfra	tmfra	wfra	wfra	tefra	tefra	wfra	fra	wfra	wfra	fra					
10	wbni	tmjni	tmjni	wbni	wbni	tejni	tejni	wbni	jni	wbni	wbni	jni					
11	wespt	tmespt	tmespt	wespt	wespt	teespt	teespt	wespt	espt	wespt	wespt	espt					
12	wreu	tmreu	tmreu	wreu	wreu	tereu	tereu	wreu	reu	wreu	wreu	reu					
13	wpol	tmopol	tmopol	wpol	wpol	tepol	tepol	wpol	pol	wpol	wpol	pol					
14	whun	tmhun	tmhun	whun	whun	tehun	tehun	whun	hun	whun	whun	hun					
15	wcze	tmcze	tmcze	wcze	wcze	tecze	tecze	wcze	cze	wcze	wcze	cze					
16	wreur	tmreur	tmreur	wreur	wreur	tereur	tereur	wreur	reur	wreur	wreur	reur					
17	wrobu	tmrobu	tmrobu	wrobu	wrobu	terobu	terobu	wrobu	robu	wrobu	wrobu	robu					
18	wtur	tmur	tmur	wtur	wtur	tetur	tetur	wtur	tur	wtur	wtur	tur					
19	wroecd	tmroecd	tmroecd	wroecd	wroecd	teroecd	teroecd	wroecd	roecd	wroecd	wroecd	roecd					
20	wcis	tmcis	tmcis	wcis	wcis	tecis	tecis	wcis	cis	wcis	wcis	cis					
21	wmerc	tmmerc	tmmerc	wmerc	wmerc	temerc	temerc	wmerc	merc	wmerc	wmerc	merc					
22	wrow	tmrow	tmrow	wrow	wrow	terow	terow	wrow	row	wrow	wrow	row					
23	wglo	tmglo	tmglo	wglo	wglo	teglo	teglo	wglo	glo	wglo	wglo	glo					
24																	
25																	
26																	

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 *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 *owatpmarg* needs to be repeated for each member of *c*, i.e., for each type of trade margin.

7.1.3 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 7.1.3.1 Model Sets Worksheet

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

7.1.4 Results Sets

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 (`womod_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 7.1.4.1 Results Set Worksheet

Results sets							
A	B	C	D	E	F	G	H
1	Results sets						
2							
3	Sets for Structural results						
4	stab1 (description)		stab2 (description)			stab3 (description)	
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 oif by region shares			stGOVTregDEM government domestic demand by total domes	
8	stQABSORP absorption		stIMPcomCIF Imports valued oif 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	stGDPVA 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 comm	
17	stYFTOT factor income					stQEcomSUP domestic ouput to export market by commod	
18	stYFDISTTOT distributed factor income						
19	stYFLABTOT labour factor income						
20	stTOTSAY total savings						
21	stHOSAY household savings						
22	stGOVSAY government savings						
23	stFSAY foreign savings						
24	stDEPREC depreciation						
25	stMTAX 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 two-level production nest where the top level can be CES – the default – or Leontief – as in the GTAP model, CET functions on the export side and a linear expenditure system. Thus, ANARRES requires several 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.¹¹

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

¹¹ 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.

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 ‘comelastm’, 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.¹² 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**.

Figure 7.2.1.1 Substitution Elasticities for GLOBE Model - illustration

	A	B	C	D	E	F	G	H	I
1	Model Specific Commodity Elasticities								
2	Elasticities								
3									
4	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	ELASTM	
5			deu	ita	aut	gbr	fra	bnl	espt
6	Grains	ogran	2	2	2	2	2	2	2
7	Sugar cane and beet	osob	2	2	2	2	2	2	2
8	Other crops	oocrp	2	2	2	2	2	2	2
9	Plant based fibres	opbf	2	2	2	2	2	2	2
10	Livestock	clstk	2	2	2	2	2	2	2
11	Raw milk	cmilk	2	2	2	2	2	2	2
12	Other animal products	caprd	2	2	2	2	2	2	2
13	Minerals	cmns	2	2	2	2	2	2	2
14	Meat	omeat	2	2	2	2	2	2	2
15	Meat products	cmprd	2	2	2	2	2	2	2
16	Vegetable oils and fats	cvof	2	2	2	2	2	2	2
17	Dairy products	cdair	2	2	2	2	2	2	2
18	Sugar	csuga	2	2	2	2	2	2	2
19	Other food products	cofd	2	2	2	2	2	2	2
20	Beverages and tobacco	cobto	2	2	2	2	2	2	2
21	Base industries	cobnd	2	2	2	2	2	2	2
22	Manufactures	cmanu	2	2	2	2	2	2	2
23	Machinery	cmach	2	2	2	2	2	2	2
24	Utilities	cutil	2	2	2	2	2	2	2

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

¹² This is different to the case in the GTAP model where the substitution elasticities are common across regions and are only differentiated by commodity.

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.¹³ 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 7.2.1.1.

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

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.¹⁴ 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 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**.

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 may 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)

¹³ 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.

¹⁴ 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.

flexibility. Except for the additional column of identifiers for this table, *ELASTY*, is identical to those for commodities and activities see 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**.

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 . 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* and *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 7.2.4.1 Frisch Elasticities for GLOBE

	A	B	C	D
1	Model Specific Household Elasticities			
2	Elasticities			
3				
4	ELASTF	ELASTF	ELASTF	
5			hous	
6	Germany	deu	-1	
7	Italy	ita	-1	
8	Austria	aut	-1	
9	United Kingdom	gbr	-1	
10	France	fra	-1	
11	Benelux	bnl	-1	
12	Spain and Portugal	espt	-1	
13	Rest of EU 15	reu	-1	
14	Poland	pol	-1	
15	Hungary	hun	-1	
16	Czech Republic	cze	-1	
17	Rest of EU 25	reur	-1	
18	Romania and Bulgaria	robu	-1	
19	Turkey	tur	-1	
20	Rest of the OECD	roecd	-1	
21	Former communist block	cis	-1	
22	MERCUSOR	merc	-1	
23	Rest of the 'World	row	-1	
24	Globe	glo	-1	
25				
26				

7.3 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.

7.3.1 Model Controls

The `mod_control` parameters are contained in a data table that consists of various elements – Figure 7.3.1.1. Also included are examples of typical default values and brief descriptions of the role of each parameter in the configuration of the model.

Figure 7.3.1.1 Model Controls

	A	B	C	D	E
1	Control Parameters				
2	These values are used to initialise various parameters that condition the model and control th				
3					
4					
5	mod_control				
6					
7	mcons				
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 aqx
11	samscal	0.001			SAM scaling factor and initial value for autoscaling
12	scal targ	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 *armelst*, *cetelast*, *qceelast* 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 to scale any elasticities taken from GTAP using uniform scaling parameters *armscal*, *cetscal* and *qxscal*.

7.3.2 Flow Controls

The flow controls are 1/0 parameters; if the parameter has a value of 1 then an action is implemented and if its value is zero it is not implemented. Overwhelmingly the flow control parameters determine whether an If statement is implemented or not; when a statement is implemented it typically controls output, either by running an *INCLUDE* file that produces output or implementing a display or export command in GAMS. The parameters in the `flow_control` table are shown in Figure 7.3.2.1.

Figure 7.3.2.1 Flow Controls

28				
29	flow_control			
30				
31	feons			
32	disp1	1	IF 1 then implemented; IF 0 NOT implemented	Control on DISPLAY Statements for read in SETS and DATA
33	disp2	1	IF 1 then implemented; IF 0 NOT implemented	Control on parameter DISPLAY Statements
34	disp3	1	IF 1 then implemented; IF 0 NOT implemented	Control on variable initialisation DISPLAY Statements
35	outGD%modS	1	IF 1 then implemented; IF 0 NOT implemented	Control on GD%Unload for Model SAM
36	outGD%parm	1	IF 1 then implemented; IF 0 NOT implemented	Control on GD%Unload for ALL model parameters
37	outGD%var0	1	IF 1 then implemented; IF 0 NOT implemented	Control on GD%Unload for ALL base values for variables
38	outGD%varL	1	IF 1 then implemented; IF 0 NOT implemented	Control on GD%Unload for ALL initialised values for variables
39	outGD%data	1	IF 1 then implemented; IF 0 NOT implemented	Control on GD%Unload for ALL model base data
40	micssamgchk	1	IF 1 then implemented; IF 0 NOT implemented	Control for checking at micro SAMG level
41	reslevel	1	IF 1 then womod_reslevel runs; IF 0 then womod_reslevel does not run	
42	ressamg	0	IF 1 then womod_ressamg runs; IF 0 then womod_ressamg does not run	
43	resmacro	1	IF 1 then womod_resmacro runs; IF 0 then womod_resmacro does not run	
44	resstruot	1	IF 1 then womod_resstruot runs; IF 0 then womod_resstruot does not run	
45	reswelf	1	IF 1 then womod_reswelf runs; IF 0 then womod_reswelf does not run	
46	resindex	0	IF 1 then womod_resindex runs; IF 0 then womod_resindex does not run	
47	restaxstr	0	IF 1 then womod_restaxstr runs; IF 0 then womod_restaxstr does not run	
48	resperc	1	IF 1 then womod_resperc runs; IF 0 then womod_resperc does not run	
49	resbase	1	IF 1 then basis for comparative results are initial values; IF 2 then bases are from an experiment	
50				
51				

7.4 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 7.4.1 Data 'Layout' Worksheet

	A	B	C	D	E	F	G	H
1	LAYOUT							
2								
3	Data Type	Name	Location	Row dim	Column	Total dimension		
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!J5	1				
10	dset	cagr	sets!J5	1				
11	dset	onat	sets!K5	1				
12	dset	ofd	sets!L5	1				
13	dset	cind	sets!M5	1				
14	dset	cuti	sets!N5	1				
15	dset	oser	sets!O5	1				
16	dset	cagg	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	aind	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				

8. Model Calibration Checks

The GLOBE model has a number of 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 kapworsys’, ‘var globeslack’ – 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. Experiment File Template

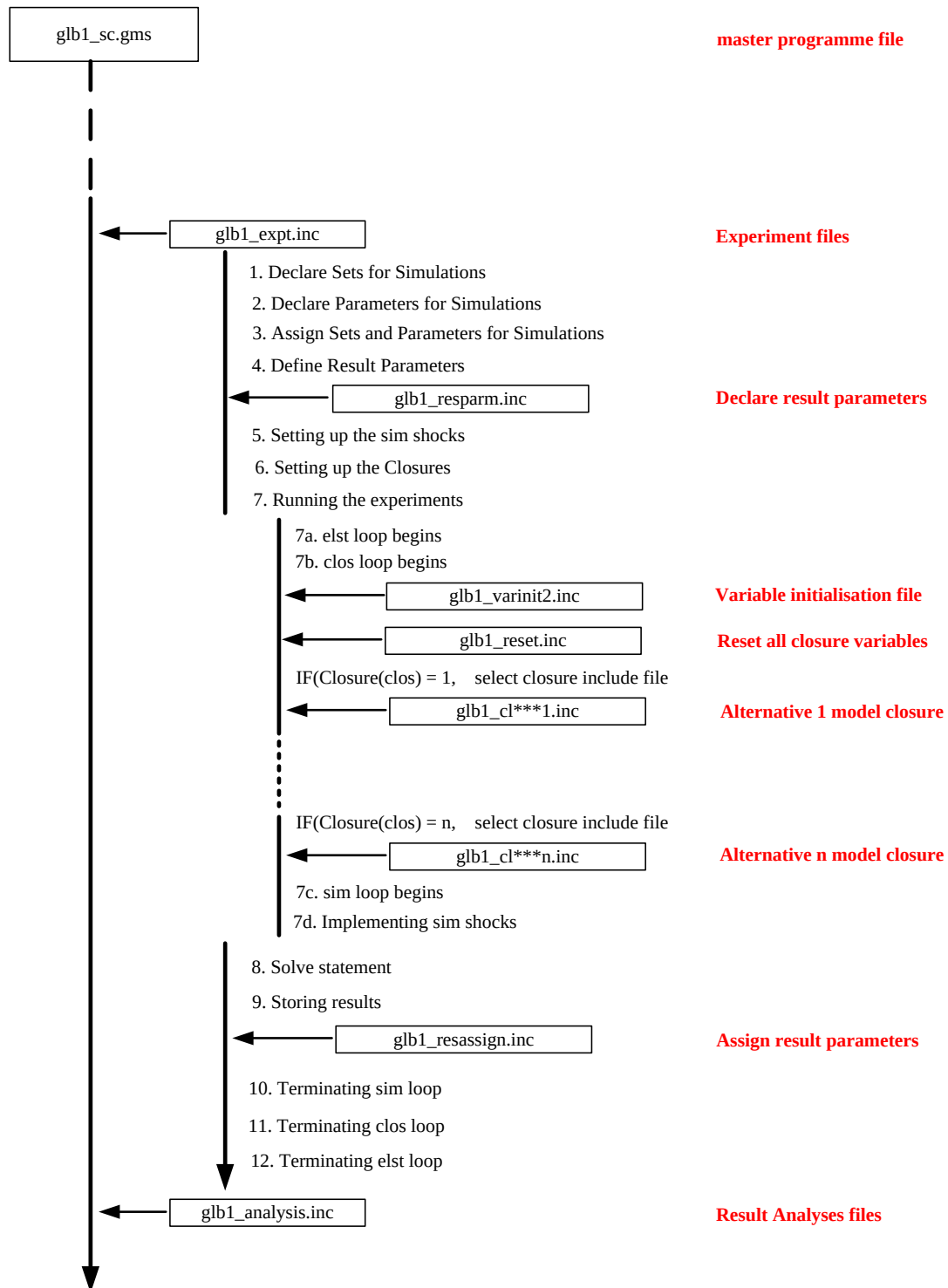
The experiment file is where the user has to be most active. The model file is largely straightforward and any changes the user would make are standardised, but the range of potential changes in the experiment file are very large and defy standardisation.

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

`glbl_reset.inc.`

Figure 9.1.1 GLOBE Experiment File Structure

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).

10. 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
- `sim1` applied Simulations set
- `sim2` 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 ‘sim1’, 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

	A	B	C	D	E	F	G	H
1	Simulation sets							
2								
3	Simulations set			Applied Simulations set		Reported Simulations set		
4	sim	(description)		sim1	(description)	sim2	(description)	
5	base	base simulation		base	base simulation	base	base simulation	
6	sim02	remove EU27 export taxes		sim02	remove EU27 export taxes	sim02	remove EU27 export taxes	
7	sim03a	half remove EU27 Import duties		sim03a	half remove EU27 Import duties	sim03	remove EU27 Import duties	
8	sim03	remove EU27 Import duties		sim03	remove EU27 Import duties	sim04	remove EU27 trade taxes	
9	sim04	remove EU27 trade taxes		sim04	remove EU27 trade taxes	sim05	common EU27 Average trade taxes	
10	sim05	common EU27 Average trade taxes		sim05	common EU27 Average trade taxes	sim07	common EU27 Average factor use taxes	
11	sim06	common EU27 Exogenous trade taxes		sim06	common EU27 Exogenous trade taxes	sim09	EU27 harmonisation on Average tax rates	
12	sim07a	half common EU27 Average factor use taxes		sim07a	half common EU27 Average factor use taxes			
13	sim07	common EU27 Average factor use taxes		sim07	common EU27 Average factor use taxes			
14	sim08	common EU27 Exogenous factor use taxes		sim08	common EU27 Exogenous factor use taxes			
15	sim09a	part EU27 harmonisation on Average tax rates		sim09a	part EU27 harmonisation on Average tax rates			
16	sim09	EU27 harmonisation on Average tax rates		sim09	EU27 harmonisation on Average tax rates			
17	sim10	EU27 harmonisation on Exogenous tax rates						
18								

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.¹⁵ 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

	I	J	K	L	M	N
1						
2						
3	Closures set			Elasticities set		
4	clos	(description)		elst	(description)	
5	clbase	Balanced macro closure		elst01	base elasticities	
6	clos02	IPTS long run closure full emptyt				
7	clos03	IPTS long run closure unemptyt				
8	clos04	IPTS short run closure unemptyt				
9						
10						
11						
12						
13						
14						
15						
16						
17						

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.

¹⁵ 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.

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 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

	A	B	C	D	E	F	G	H	I	J	K	L
1	Experiment file sets											
2	This file contains specific sets created to run particular experiments											
3												
4	reu15	(description)		reunew	(description)		reu25	(description)		reu25n	(description)	
5	deu	Germany		pol	Poland		deu	Germany		robu	Romania and Bulgaria	
6	ita	Italy		hun	Hungary		ita	Italy		tur	Turkey	
7	aut	Austria		cze	Czech Republic		aut	Austria		roecd	Rest of the OECD	
8	gbr	United Kingdom		reur	Rest of EU 25		gbr	United Kingdom		cis	Former communist block	
9	fra	France					fra	France		merc	MERCUSOR	
10	bnl	Benelux					bnl	Benelux		row	Rest of the World	
11	espt	Spain and Portugal					espt	Spain and Portugal		glo	Globe	
12	reu	Rest of EU 15					reu	Rest of EU 15				
13							pol	Poland				
14							hun	Hungary				
15							cze	Czech Republic				
16							reur	Rest of EU 25				
17												
18												
19												
20												
21												

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 econs

A7	econs									
	A	B	C	D	E	F	G			
1	Control Parameters									
2	These values are used to initialise various parameters that condition experiments using the GLOBE programme									
3										
4										
5	exp_control									
6										
7	econs									
8	reslevel	1			IF 1 then womod_reslevel runs; IF 0 then womod_reslevel does not run					
9	ressamg	0			IF 1 then womod_ressamg runs; IF 0 then womod_ressamg does not run					
10	resmacro	1			IF 1 then womod_resmacro runs; IF 0 then womod_resmacro does not run					
11	resstruct	1			IF 1 then womod_resstruct runs; IF 0 then womod_resstruct does not run					
12	reswelf	1			IF 1 then womod_reswelf runs; IF 0 then womod_reswelf does not run					
13	resindex	0			IF 1 then womod_resindex runs; IF 0 then womod_resindex does not run					
14	restaxstr	0			IF 1 then womod_restaxstr runs; IF 0 then womod_restaxstr does not run					
15	resperc	1			IF 1 then womod_resperc runs; IF 0 then womod_resperc does not run					
16	resbase	1			IF 1 then basis for comparative results are initial values; IF 2 then bases are from an experiment					
17										

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

A1	Common External Tariff of EU15 and EU25 with Trade Partners in accordance with the Regional and Commodity Aggregation of ANEFIS, ad valorem in %													
	A	B												
1	Common	External Tariff of EU15 and EU25 with Trade Partners in accordance with the Regional and Commodity Aggregation of ANEFIS, ad valorem in %												
2														
3														
4	EU15													
5		cgran	cscb	coorp	cpbf	clstk	cmik	caprd	cmins	cmeat	cmprd	cvof	cdair	csu
6	wdeu	0	0	0	0	0	0	0	0	0	0	0	0	0
7	wita	0	0	0	0	0	0	0	0	0	0	0	0	0
8	waut	0	0	0	0	0	0	0	0	0	0	0	0	0
9	wgbr	0	0	0	0	0	0	0	0	0	0	0	0	0
10	wfra	0	0	0	0	0	0	0	0	0	0	0	0	0
11	wbni	0	0	0	0	0	0	0	0	0	0	0	0	0
12	wespt	0	0	0	0	0	0	0	0	0	0	0	0	0
13	wreu	0	0	0	0	0	0	0	0	0	0	0	0	0
14	wpol	11.656	10.113	0.984	0	33.506	0	1.844	0	69.09	16.814	3.408	41.365	
15	whun	6.642	0	2.686	0	16.129	0	2.955	0	52.264	14.134	0.573	29.953	
16	wcze	3.763	0	0.758	0	50.422	0	2.802	0	52.851	11.972	8.733	44.389	
17	wreu	1.468	63.055	1.149	0	21.137	0	1.249	0	35.94	11.504	3.578	40.121	
18	wrobu	15.366	2.057	18.084	0.204	3.373	0	7.091	2.032	30.062	42.726	10.192	26.932	
19	wtur	31.866	19.022	19.46	0	3.776	0	2.12	0	65.09	72.894	13.564	84.425	
20	wroecd	17.616	13.909	11.108	0.445	1.958	0	4.218	0.353	35.176	50.065	4.334	34.186	
21	wcis	55.272	52.808	16.304	1.944	1.897	0	3.826	1.936	26.106	28.241	15.681	23.847	
22	wmerc	10.863	9.544	7.445	9.271	5.342	0	7.045	4.729	11.965	14.517	12.941	19.203	
23	wrow	14.462	30.776	13.024	5.597	0.985	0	8.143	6.6	15.121	15.259	15.785	11.04	
24	wglo	0	0	0	0	0	0	0	0	0	0	0	0	
25														
26														
27														
28														
29														
30	EU25													
31		cgran	cscb	coorp	cpbf	clstk	cmik	caprd	cmins	cmeat	cmprd	cvof	cdair	csu
32	wdeu	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

A1 LAYOUT						
	A	B	C	D	E	F
1	LAYOUT					
2						
3	Data Type	Name	Location	Row dimension	Column dimension	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	moons	controls!A7	1		
26	dset	foons	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		

11. 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

	- 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 why 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                      = ERPIO * numerchk ;

* globe transactions are in the numeraire currency

ER.FX("glo")                 = ERPIO * 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)          = FD0(lu,a,rluex) ;
* WF.FX(lu,rluex)           = WF0(lu,rluex) ;
* 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)          = FD0(lu,a,rluen) ;
  WF.FX(lu,rluen)           = WF0(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)             = FD0(ls,a,r) ;
* WF.FX(ls,r)               = WF0(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)              = FD0(k,a,r) ;
* WF.FX(k,r)                = WF0(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)            = FD0(lnd,a,r) ;
* WF.FX(lnd,r)              = WF0(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)        = FD0("NatRes",a,r) ;
* WF.FX("NatRes",r)          = WF0("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 ;

12. 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*.

13. Technology Shocks

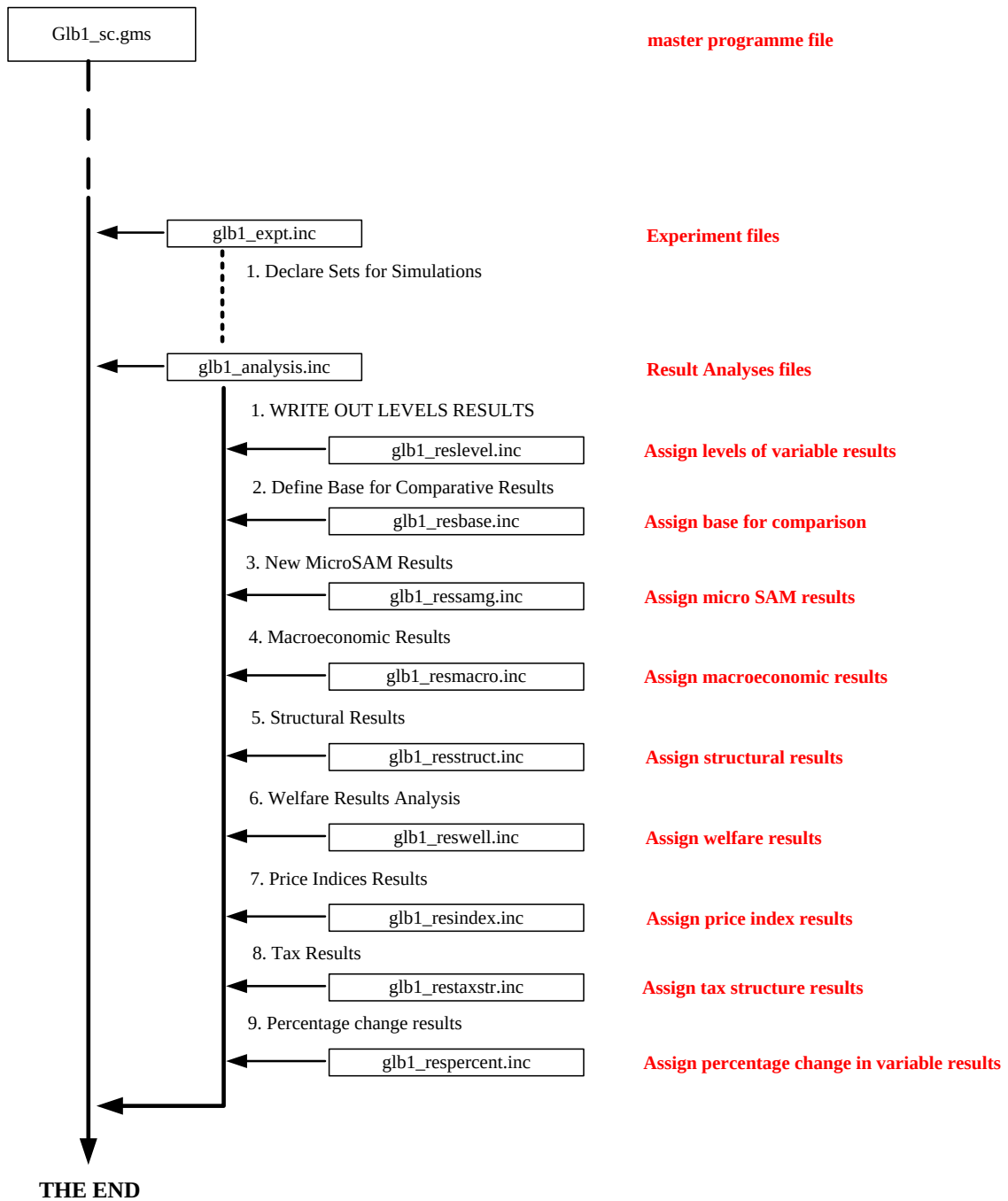
In order to assist the user the template experiment file comes complete with declaration statements for technology shocks, i.e.,

```
* 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*.

14. 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).

Figure 14.1 ANARRES 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.

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