Global CGE Modelling Course: ANARRES_t Exercises Module G1

cgemod

Table of Contents

1. Introduction

These exercises are an introduction to ANARRES_t. The exercises use a very aggregated database (4 commodities/activities, 4 factors and 3 regions), however the model code could be used for most aggregations[1] of the GTAP database that was structured to be consistent with the model (anar_t). The documentation for these exercises becomes progressively less prescriptive as you progress through them: it is assumed that (i) you will be becoming more independent and (ii) increasingly you will be adopting your own methods. During the course, however, we encourage you to stay close to our methods since it makes progression through the exercises easier and reduces confusion. The four exercises detailed in this part of the ANARRES_t programme cover the materials covered in module G1.

We start with the mechanics of using an already configured model (`anar_t`) to run a simple experiment to check the model (Ex G1.1), then we describe a standard FTA experiment (Ex G1.2), which is then implemented using GAMS's Save and Restart facility (G2b) and an exercise that develops a method to access results (Ex G1.3). The Save and Restart facility is an efficient way to run experiments that we will use throughout the rest of the course.

These exercises for modules Mod G1 and Mod G2 all use the same (highly) aggregated database; all the techniques explored are scalable and therefore there is no real benefit from using a larger database. Moreover, it has the benefit of making the data handling and interpretation more tractable. A later set of exercises, those relating to module G3, will progress towards using a larger database, which allows the progressive development of the ability to interpret model results using ever more sophisticated analyses without needing to revisit the issues associated with the interpretation of the basic policy shocks. The data, policy shocks, sensitivity analyses and save and restart facility will be used in project G3.1 – 'Interpreting Model Results I'. In project G3.2 – 'Interpreting Model Results II' - the data and policy shocks will be changed.

[1] The limitations can arise because of (i) many regions and accounts per region rendering the model intractable due to solver issues and (ii) potential constraints imposed by the scaling of transactions across 'large' and 'small' regions causing problems with 'small' shares.

The final set of exercises is the course project. This uses an aggregation of the GTAP 8 database that you determine, within limits, to examine your own choice of policy simulations.

2. Setting up the Course Library

These instructions are for GAMS 51.4 and Studio 1.22.2. Earlier or later versions of GAMS and GAMS Studio may operate slightly differently.

All work for the course should be kept in the directory `C:\cgemod` with appropriate subdirectories as described in the exercises. During this course, the files we will use are stored in a User Library, which you will download from the course site.

The library for the global CGE modules contains zipped directories that will need to be unpacked AFTER they are downloaded from the User Library – `global_lib`.

NB: the global_lib directory contains sub directories. These sub-directories must NOT be unpacked.

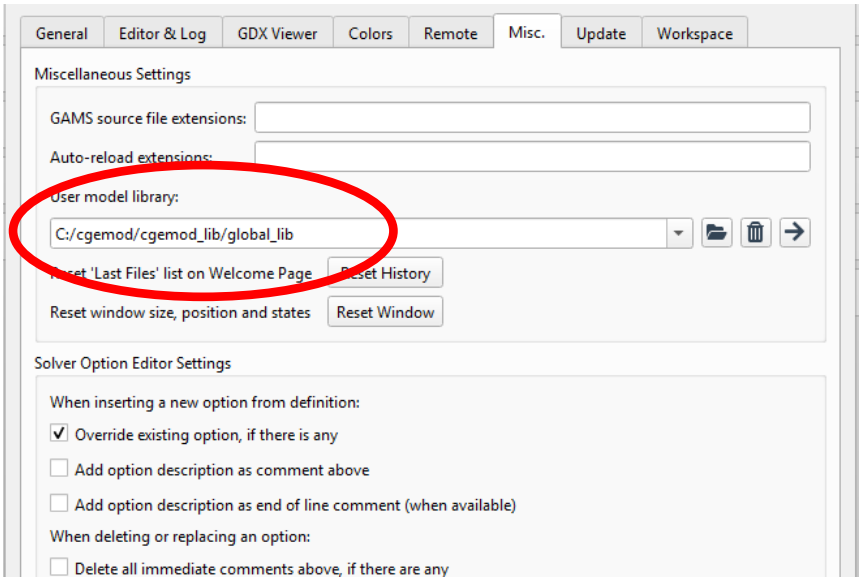
The first stage is to establish the User Library that will be used for the four modules of the Global Country CGE course and tell GAMS Studio where the User Library will be found (see section 11 of 'Introduction to GAMS and GAMS Studio'). Carry out the following actions

1. Create the library directory `C:\cgemod\cgemod_lib\global_lib`
2. Then download the zip file `global_lib.zip` from the Moodle site (it is one of the files in the folder of downloads for Topic G1.1) into your downloads directory.
3. Unzip the contents of the file `global_lib.zip` into the library directory `C:\cgemod\cgemod_lib\global_lib`. WinZip may by default unzip these files into a directory, often called `global_lib`. If so, you will need to copy these files and paste them into your library directory `C:\cgemod\cgemod_lib\global_lib`. NB: Do not unzip the zipped subdirectories in the file `global_lib.zip`; these are needed.
4. **The files in `global_lib` that are in sub directories must NOT be extracted from the sub directories**
5. Open Studio settings - `File>Settings` or `F7` or the `Settings Wheel` on the toolbar and go to the `Misc` tab.
6. Change the path for the User Model library from something like `C:\Users\…\Documents\GAMS\modellibs` (the exact path will depend on

the settings on your PC) to `C:\cgemod\cgemod_lib\global_lib` (see Figure G1.1).

7. Close the Studio `Settings` window remembering to click `APPLY` and `OK` at the bottom of the `Misc` tab.

Figure G1.1 Setting the Path for global_lib



If you work directly from the library directory, you will end up using the wrong files at some point in the course and thereby corrupt the library. Never work directly from the library directory.

RESIST THE TEMPTATION TO EXPLORE THE CONTENTS OF THE LIBRARY; THIS WAY LIES CONFUSION. YOU GET TO SEE AND USE ALL THE FILES.

3.Ex G1.1: Checking the ANARRES_t Model

This exercise is concerned with verifying that the ANARRES_t (anar_t) model is correctly configured, understanding where the data inputs are recorded and how the model is structured, implementing a simple experiment – in this instance a simple unilateral reduction in import duties – and verifying that the correct experiment has been implemented.

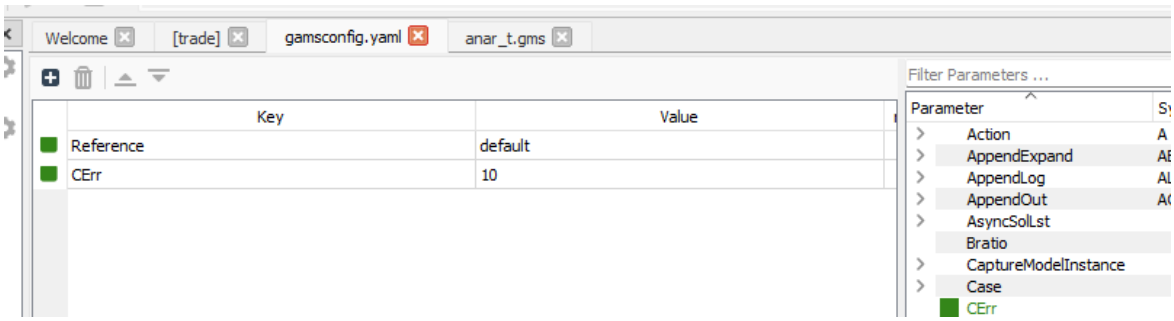
GAMS Configuration

It will be helpful if GAMS is configured to carry out two actions automatically when a programme is run (you should already be using this configuration, so this is a reminder).

1. In GAMS Studio menu select `GAMS>Default GAMS Configuration` (see Figure G1.4).
2. The course assumes you select one item (`CErr`) from the right-hand frame in the editor window and drag then to the left-hand frame.
3. The `CErr` instruction automatically stops a programme when a specified number of syntax errors have been identified; we suggest setting the entry in the Value column to 10 or less – since once one syntax error occurs others will inevitably follow it is good practice to resolve errors in the order they occur.

We assume that participants will make extensive use of the reference file. The use of reference files is covered in the course 'Introduction to GAMS/GAMS Studio (http://www.cgemod.org.uk/gams_studio.html).

Figure G1:4 GAMS Default Configuration



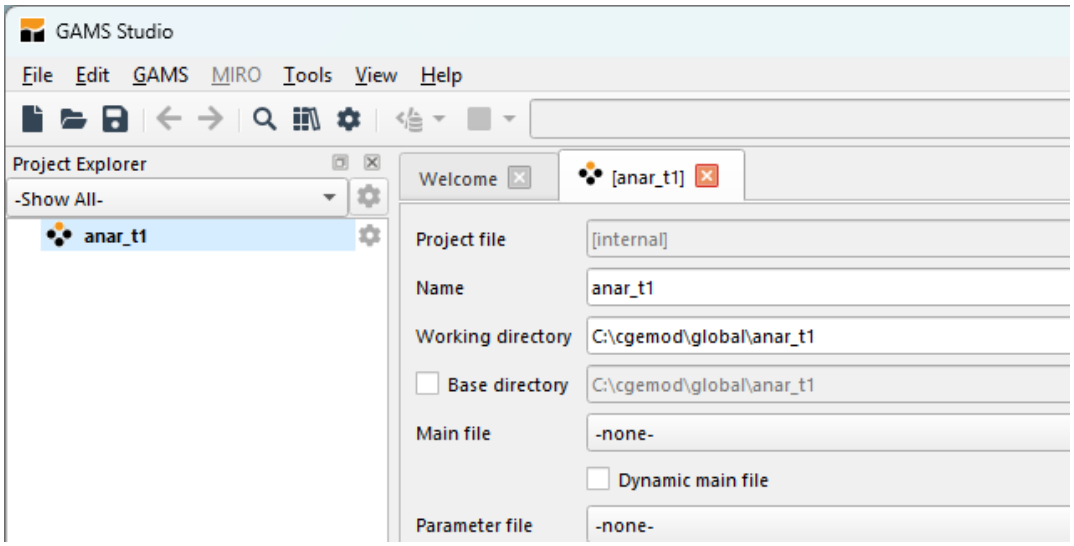
A First Global Model

This exercise provides a summary of the information needed to begin using ANARRES_t. For more details see the ANARRES_t Technical document (*Anarres_t Model.pdf*) and the ANARRES_t User Guide (*ANARRES_t User Guide.pdf*).

1. in Windows Explorer create the directory for this course, i.e., `C:\cgemod\global`,
2. in Windows Explorer create the directory for these exercises, i.e., `C:\cgemod\single\global\anar_t1`,
3. open the Settings (`F7`)
4. on the General tab make sure that the option '`Open file in current project by default`' is selected (this should already be the case),
5. choose `File>New Project` and this opens the project options in the edit viewer,
6. the default name for the project is `newProject`,
7. rename the project name as `anar_t1` (the name in Project Explorer will not change until the project is saved),
8. set the Working directory to the new project directory, e.g., `C:\cgemod\single\global\anar_t1`, using the BROWSE button,
9. note the Base directory will default to the same name as the Working directory,
10. choose `File>Save` **– DO NOT USE SAVE AS**[1]
11. now choose `File>New` (see below) that will open a Windows Explorer window with defaults File name, `new***.gms`. (this step together with step 3 above is necessary to ensure that Studio is directed to use the new project's directory),
12. click `SAVE` and `new**.gms` will appear in the `anar_t1` project in the Project Explorer.
13. You now have a New Project that is in a working directory that is effectively empty. This method will be used repeatedly although he instructions to create a New Project will be truncated.

[1] As of Studio version 1.22.2 using Save As produces an error.

Figure G1:2 Setting the Project Directory



The working directory can now be populated from the User Model Library (`global_lib`).

1. In the project `anar_t1` choose `F6` and in the `Model Library Explorer` find the library `Global CGE Course Library`. (Figure G1:3)
2. Open item 01 (`anat_t1`) in the `Global CGE Course` library, and `LOAD`,
3. The `anar_t.gms` model will now be displayed in the editor window and be listed in the Project Explorer as being in the project `anar_t1`.
4. If you right-click on the project name and select `Open Location`, you will see 4 files – 2 `gms` files, 1 `dat` file and 1 `zip` file - have been downloaded to the directory `cgemod\global\anar_t1`, one of which is a zipped archive (Figure G1.4).
5. You can delete the file `new*.gms`.
6. If you right-click on the project name and select `Open Location`, you will see the files downloaded to the directory `C:\cgemod\global\anar_t_1`. There will be a ZIP file (`anar_t_1.zip`) in the directory (see Figure G1.4),
7. Open the directory `cgemod\global\anar_t` and unzip the archive `anar_t_G1.zip`. This will add 7 sub directories to the project's directory (see Figure S1.4). **NB**: when using Windows Explorer to extract the files they can be put into a sub directory: if this happens you need to move the sub directory to the working directory. **NB: the files in each sub directory must remain in the sub directory.** The resultant directory is illustrated in Figure G1.5.

8. You also needed to change the file extension for `clean_anar.dat` to `clean_anar.bat` (this is a batch file used to 'clean' working directories but will be treated as an executable if downloaded with the `bat` file extension).
9. Studio can now be used to work with the ANARRES_t model.
10. Throughout the course the model user library to access files needed for each exercise. The instructions for setting up modules G2, G3 and G4 will be less detailed.
11. If you work directly from the library directory, you will end up using the wrong files at some point in the course and thereby corrupt the library. Never work directly from the library directory.

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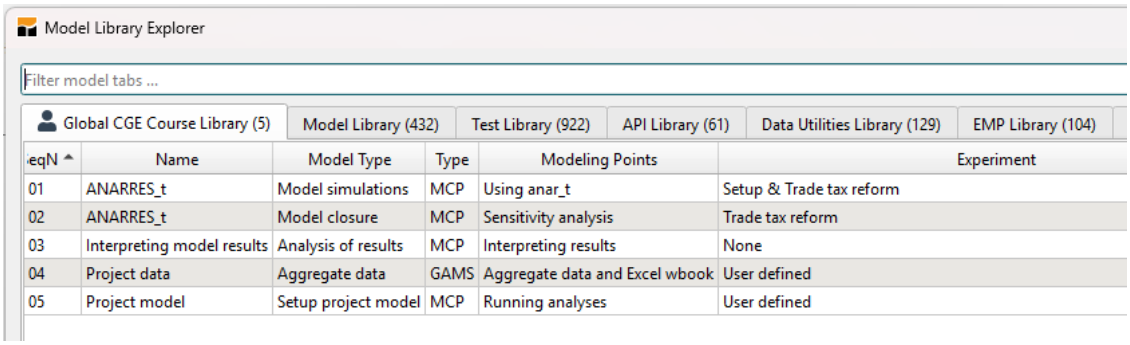
Figure G1:3 Global CGE User Library



eqN	Name	Model Type	Type	Modeling Points	Experiment
01	ANARRES_t	Model simulations	MCP	Using anar_t	Setup & Trade tax reform
02	ANARRES_t	Model closure	MCP	Sensitivity analysis	Trade tax reform
03	Interpreting model results	Analysis of results	MCP	Interpreting results	None
04	Project data	Aggregate data	GAMS	Aggregate data and Excel wbook	User defined
05	Project model	Setup project model	MCP	Running analyses	User defined

Figure G1:4 Project Directory for stg_t_1

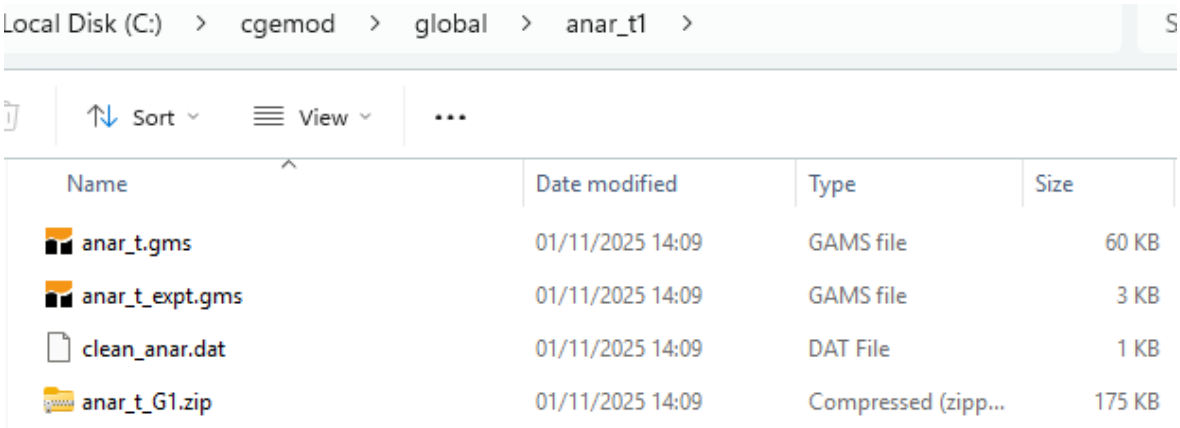
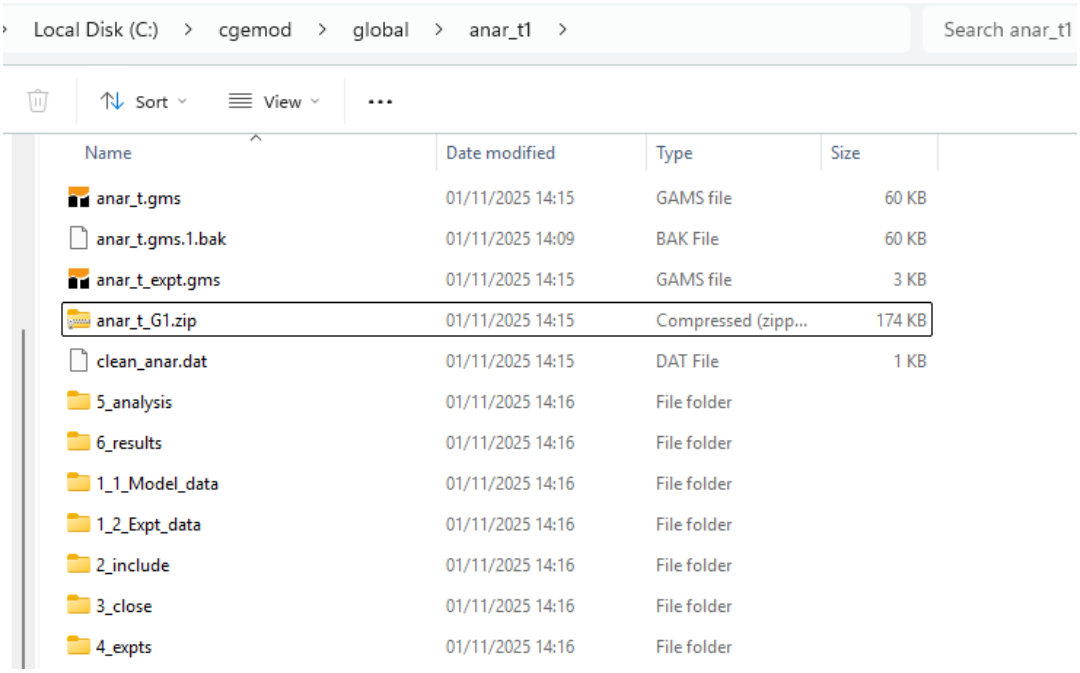


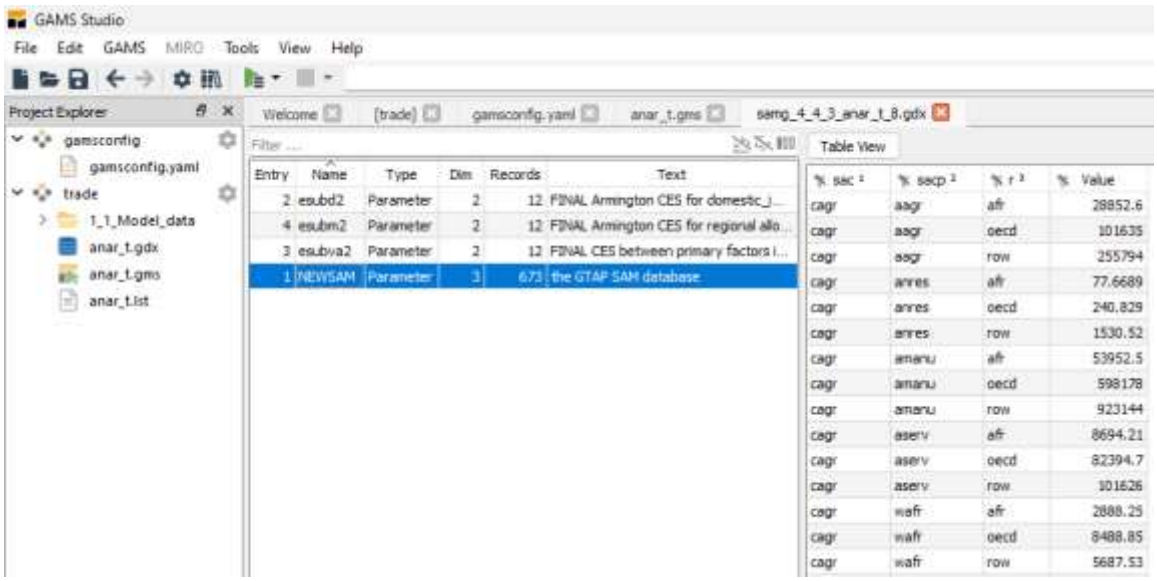
Figure G1:5 Project Directory for anar_t_1 - unzipped



Running ANARRES: the First Time

You are now ready to run `anar_t.gms` for the first time. This run of `anar_t.gms` is solely for learning about the model. It will take you longer than you expect; in part because of the directory and file structure and in part because this is a much more complicated model. Do not move on to Exercise G1.2 until you have successfully completed this exercise.

1. The file `anar_t.gms` will be open on your screen in GAMS Studio and run the model using `F10` (`Run with GDX and RF Creation`). This will generate a reference file, `anar_t.ref` and a GDX file with all model information, `anar_t.gdx`.
2. What files were used to run this programme?
3. Examine the content of the directory `C:\cgemod\global\anar_t1`. Open the file `1_1_Model Data\data_4_4_3_anar_t_8_G1.xlsx` and look at the various worksheets and answer the questions below for each worksheet:
    a. `Layout` – where are the members of set `r` found?
    b. `Sets` – who are the members of set *tmr*?
    c. `Maps`– what does the set *map_f_tff*(*f*,*tff*) do?
    d. `Maps`– what does the set `map_c_w_marg(c,w,owatpmarg)` do?
    e. `Controls`– what does *mintrans* do?
4. Go back to GAMS Studio and open the file `samg_4_4_3_anar_t_8.gdx`; your screen will look as follows:



Select the NEWSAM parameter and choose the Table View. Select the `afr` (Africa) regions and drag the second column to the right to form a matrix of results, see below.

List View

sac ¹	r ³	sacp ²	Value

	afr														
	cagr	cnres	cmanu	cserv	aagr	anres	amanu	aserv	fland	fcap	fUskil	fskil	tmafr	tmoecd	tmro
cagr					28852.6	77.6689	53952.5	8694.21							
cnres					27.1444	7862.35	90368.5	1401.91							
cmanu					32575.2	38081.7	365281	165597							
cserv					23650.4	35496.7	184213	200565							
aagr	259635														
anres		320141													
amanu			973797												
aserv				933002											
fland					22917.6	73016									
fcap					42498	136582	142891	259643							
fUskil					103878	18447.1	99226.8	157321							
fskil					957.807	3251.2	20105	117058							
tmafr	179.426	89.7836	2458.25												
tmoecd	1118.57	21.6964	13692.4												
tmrow	657.018	202.31	14427												
teafr	0.00131	34.5895	866.256												
teoecd	-0.080064	433.483	1063.47												
terow	0.012789	343.14	454.703												
tfland					297.952	964.168									
tfcap					507.935	1652.92	1673.51	3539.08							
tfUskil					2190.93	417.436	2508.76	4019.85							
tfskil					20.4604	72.3749	513.111	3018.33							
owatpafr	346.261	781.562	2635.2												
owatpoecd	819.564	224.971	8196.38												
owatprow	545.681	901.591	8138.77												
wafr	2888.25	6811.57	36930.8	1569.78											

Review the parameters in the file `samg_4_4_3_anarF_t_8_G2.gdx` and answer the following questions:

a. `NEWSAM` – what is the value of the domestic production of natural resources in Africa? What is the (value) proportion of Africa's commodity exports accounted for by natural resources? (HINT: export data to and use Excel).

b. `ESUBM2` – what is the elasticity of substitution between imports of manufactured goods from the OECD and the rest of the world in Africa, taken from the GTAP database?

c. `ESUBD2` what is the elasticity of substitution between aggregate imports and the domestic variety for agriculture in the rest of the world rest of the world, taken from the GTAP database?

In GAMS Studio open the file `data_in.gdx` – look at various parameters and sets answer the following questions

a. `elastva` – what is the value of `elastva` for manufacturing in Africa? Was this the value used in `anar_t`? If not, where were the values obtained?
b. What are the elements in the set `cnat`?
c. What is the elasticity of substitution between primary factors in the production of services in the OECD region?

Carry out the following checks for the model and answer the questions. (HINT: use `anar_t.lst` or `anar_t.gdx`). See the presentation `ANARRES_t Model Checks ppt.pdf/mp4`

a. Check that `VAR WALRAS` is equal to 0 for all regions; check `VAR ANARRESSLACK` and `VAR KAPWORSYS` are equal to zero;
b. Check that all the `LHS` (left hand sides) are correct – search for "`LHS`" and then search (from cursor) for "`***`" (which indicates a problem).
c. For additional certainty search for "`infes`".

Checking that the base SAM is replicated (HINT: use `anar_t.lst` or `anar_t.gdx`)

a. Search for
    i. ASAMG1
    ii. CHECK
    iii. ASAMG1CHK
    iv. DIFFASAMG1
    v. CNTASAMG1
    vi. SAMG1CHK
    vii. DIFFSAMG1
    viii. CNTSAMG1
b. Verify what each parameter means and then check that the reported values are correct.

Checking that the calibrated SAM is replicated:

c. Search for
    i. ASAMG2
    ii. CHECK2
    iii. ASAMG2CHK
    iv. DIFFASAMG2

v. CNTASAMG2

vi. SAMG2CHK

vii. DIFFSAMG2

viii. CNTSAMG2

d. Verify what each parameter means and then check that the reported values are correct.

Check that you can find these values in both `anar_t.lst` and `anar_t.gdx`. Finally check the model is homogenous degree zero: in the workbook `data_4_4_3_anar_t_8_G2.xlsx` go to the worksheet `controls` and change the entry in cell `B8` to **2** and rerun the model. We are doubling the numéraire,

a. What should this do?

b. What should the effect be on quantities and prices?

c. How can you check the effects?

Reset the numéraire check parameter and rerun. Make sure the model has replicated correctly.

Use `clean_anar.bat` (note you will need to change the suffix on `clean_anar.dat` to `bat` – this is because files with the suffix `bat` can trigger errors when downloading files) sub directory.

1	**Control Parameters**			
2	**These values are used to initialise various parameters that condition the model and control the operation of the programme**			
3				
4				
5	**mod_control**			
6				
7	**mcons**			
8	numerchk	2		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	scaltarg	100		target level for auto scaling
13	scalprop	0.95		proportion of NON zero elements that must be below the target level
14	armelast	1		IF 1 then ALL Armington elasticities from Excel; IF 2 ALL from 'GTAP'
15	armscal	1		Scaling value for GTAP Armington elasticities - divided by armscal
16	cetelast	1		IF 1 then ALL CET elasticities from Excel; IF 2 ALL from 'GTAP'
17	cetscal	1		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	smimpsh	0.001		Range 0 to 1; If 1 then NO LARGE shares; If 0 then NO SMALL shares

Using $SETGLOBAL

The $SETGLOBAL is a string substitution facility. One use of this facility, which we use, is to simplify the process of providing the model with details about files that should be read by the model. This is useful because it can be the case that a named file is embedded in the code and searching for and replacing the file name can be a 'fiddle'. It is also convenient because it is our practice to ensure all data used by any **.gms file are entered in one place.

An example will make the operation clearer. The database used for this model is stored in two files data_4_4_3_anar_t_8_G.xlsx and samg_4_4_3_anar_t_8.gdx that are read in by the file anar_t_dataload.inc. Rather than editing the file anar_t_dataload.inc, and probably needing to save the file with a new name to indicate the data that is used, we use $SETGLOBAL.

In the file anar_t.gms we add two $SETGLOBAL instructions in lines 125 to 132 (see below)

```
*~~~~~~~ Model Data
*~~~ Excel Data File
$SETGLOBAL  mod_xls_data     data_4_4_3_anar_t_8_G1
*~~~ GDX Data File
$SETGLOBAL  mod__gdx_data    samg_4_4_3_anar_t_8
```

which assigns the string 'DATA_4_4_3_anar_t_8_G2' to 'mod_xls_data' and the string 'SAMG_4_4_3_anar_t_8' to 'mod__gdx_data'.

In the file anar_t_dataload.inc the Excel data file is called in using a $CALL instruction (line 80)

```
$CALL "GDXXRW i=1_1_Model_data/%mod_xls_data%.xlsx o=data_in.gdx
                                    INDEX=LAYOUT!A4 trace=3"
```

where the string %mod_xls_data% is replaced by data_4_4_3_anar_t_8_G1, to identify the (i)nput file used to create the o(utput) file data_in.gdx.

In the file anar_t_dataload.inc the GDX data file is call using a $GDXIN instruction (line 128)

```
$GDXIN 1_1_Model_data/%mod__gdx_data%.gdx
```

where the string `%mod_gdx_data%` is replaced by `SAMG_4_4_3_anar_t_8.`

We will use this facility throughout the course.

4. Ex G1.2: Tade Tax Policy Experiments

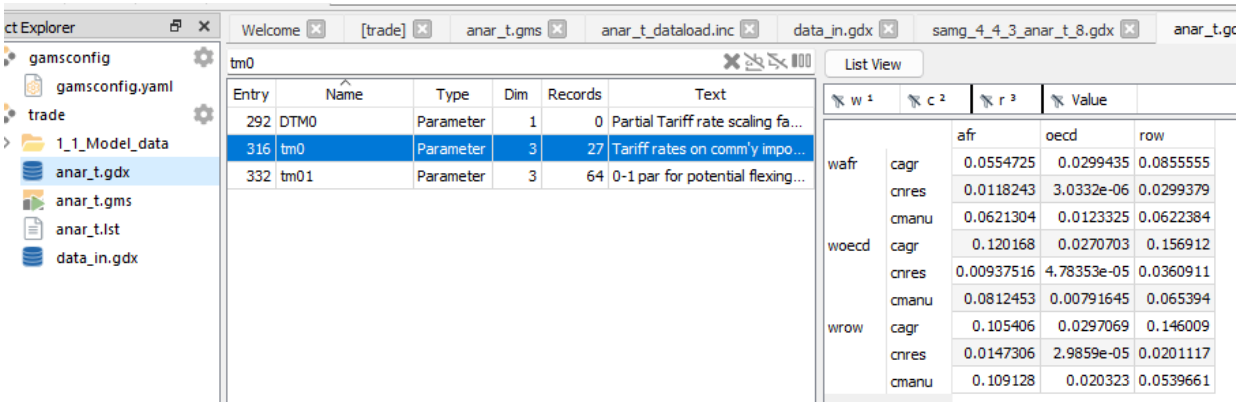
For this exercise we will consider the implementation of a free trade agreement (FTA). We will consider an FTA in which tariffs on all commodities are reduced for FTA members. A series of sims are designed to allow us to decompose how sensitive the results are to the components of the shocks. We also consider an FTA in which tariffs are reduced for a subset of commodities, representing the case in which some commodities are contentions and are left out of the agreement. Since these experiments will be conducted using a global model the implications are not limited to a single country nor just the partners in the FTA. An important part of these experiments will be the importance of disentangling which parts of the agreement are responsible for which elements of the results.

Form a Free Trade Agreement between OECD and Africa

We will form an FTA between the OECD and Africa. The objective is full bilateral liberalization of trade, so import duties and export taxes will be removed. It is assumed that there is full employment, and all factors are fully mobile within a region. The changes in tariff revenues reduce government savings. We will use base level elasticities.

1. We will continue to work in the directory `C:\cgemod\anar_t\anar_t1`. Open `GAMS Studio` and review the `anar_t.gdx` file which you generated in Exercise G1.1.
    a. What are the base level tariffs (parameter `tm0`) on Africa's imports from the OECD? See the figure below and note that Africa's tariffs on imported agriculture from the OECD is 0.12016799810583. This degree of 'precision' is necessary to ensure that the model will pass tests. It reflects the decision by GTAP to record transactions in millions of USD to 6-decimal places.[1]
    b. How can you configure GAMS Studio to display the maximum number of decimal places?

[1] This derives from the properties of GEMPACK where all possible transactions must have non-zero values to avoid computational problems associated with solving in log differences.

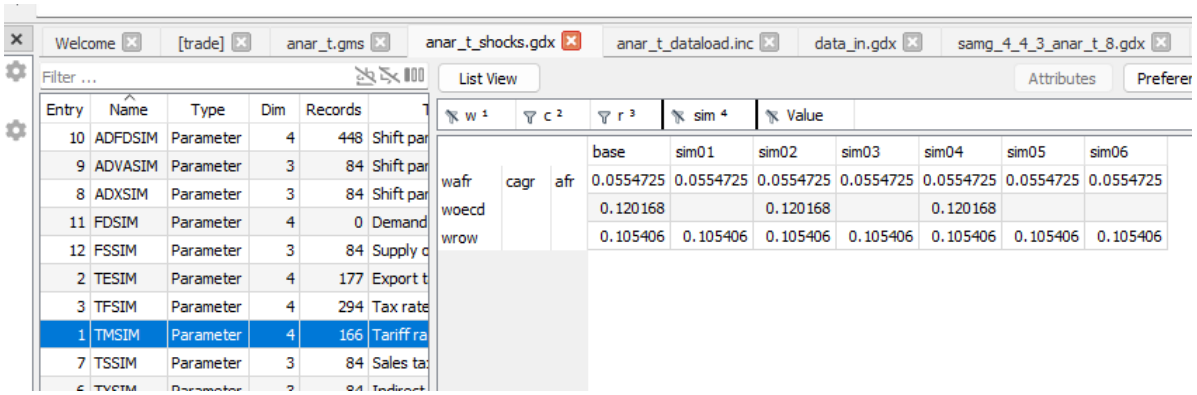


2. Review the file `3_close\anar_t_cl_base.inc`. This has default settings, but not necessarily 'ideal' settings, for a macroeconomic closure file. Verify that a change in tariff revenue would affect government savings and that there is full employment with all factors fully mobile.
3. In this exercise, we will run a series of experiments in a loop over simulations. In later exercises, we will also loop over closure and elasticity choices. A loop is run over a set. You will need to assign elements to the set `sim`. This is done in the excel workbook `1_2_Expt_data\data_anar_t_expt_G1_2.xlsx`. Open the file in Excel and review the tab `simsets`. We will design a simple series of simulations to decompose how sensitive the results are to the components of the shocks. Note that the entry of the first element of the set `sim` is called "`base`": the set element for the `base` should not be changed when you edit the experiment workbook for any subsequent project. The code uses "`base`" when assigning results. In later exercises, we will expand the loops used in experiments and assign additional elements to sets `elst` and `clos`.
4. Add the following elements and description to the set `sim` by listing them under `base`, starting in cell A6.

sim01	remove bilateral import duties
sim02	remove bilateral export duties
sim03	remove bilateral import and export duties
sim04	OECD remove all import duties on afr
sim05	afr remove all import duties on OECD
sim06	remove bilateral import duties exempt mfg for afr

5. The set `simc` is a subset of `sim`; it is the simulations run in the experiment. It gives you the option of running a subset of the list of sims. Here, we will run all 6 sims and the `base`. Copy the list of simulations and the descriptions to the column for `simc`, starting at cell `D6`.

6. We will also need to define sets used in the experiment. Review the tab `expsets`. It has information for subsets of regions in the FTA. Assign `afr` and `oecd` to the set `rfta` which is a subset of the regions `r`; assign `wafr` and `woecd` to the set `wfta`, which is a subset of trade partners `w`. Why do we need two region subsets for the simulations?
7. Save the Excel workbook.
8. In GAMS Studio, open the file `4_expts\anar_t_expt_G1_2.inc`. Search for `"Declaring Parameters for Shocks"`. Review the parameters used for policy shocks. We will use the parameters `TMSIM(w,c,r,sim)` and `TESIM(c,w,r,sim)` for the policy shocks needed. Note the index ordering, why is it different for tariffs and export taxes?
9. Search for `"Assigning Parameters for the Shocks"`. This is where you will define the policy shocks. Note that each shock parameter is assigned the base value. For example, `TMSIM(w,c,r,sim) = TM0(w,c,r)` ; To assign a policy shock, you will assign information for the specific elements of `sim`.
10. In the section `* Bilateral import duty removal` assign the tariffs needed for each sim, which will be listed explicitly as `"sim01"` etc. No need to assign the base because that taken care of when `TMSIM(w,c,r,sim)` is initialized at `TM0(w,c,r)`. The information for the first simulation is provided in the code.
11. In the section `Bilateral export tax removal`, assign the export tax rates needed for each sim.
12. Add the file `anar_t_expt_G1_2.inc` in the policy experiments section at the end of the file `anar_t.gms`.
13. Do NOT switch on the file `5_analysis\anar_t_anal.inc`.
14. Run the model with `F10`.
15. Open the file `anar_t_shocks.gdx` in `GAMS Studio`. It reports values for all shock parameters used in the experiment file. See the results below for `TMSIM` filtered for the region `afr` and commodity `cagr`: Note, there are many ways to filter and organize the results, there is no "correct" way. You will develop the method that works best for you.



16. Can you determine the values used in the simulation from the shocks file?
17. Review the information in the file `anar_t_struct.gdx`. This will be in the `results` subdirectory. Review the file `anar_t_struct.inc` to see how each parameter is defined.
    a. How important is the OECD as a source of total imports in Africa?
    b. How important is Africa as a source of total imports for the OECD?
    c. Which commodity does Africa export the most?
    d. What is the most important import the OECD has from Africa (i.e., which commodity has the biggest share of total imports from Africa)?
    e. What is the most important import Africa has from the OECD (i.e., which commodity has the biggest share of imports from the OECD)?
    f. Which country is Africa's largest export partner?
    g. Which country is the OECD's largest export partner?
18. Note down your expectations about the likely impact of the experiments on the economy.
19. The results for all variables in the model for all of the simulations are reported in the file `anar_t.gdx` that was generated by using `F10`.
20. Review the results for the variables and confirm that the intended shocks were implemented.
21. Now review the other results and assess the extent to which the variable values moved in line with your expectations. Consider the following questions
    a. What happened to trade volumes?
    b. What happened to the basic prices of imports and exports?
    c. What happened to purchaser prices?
    d. What happens to household incomes and consumption expenditure?
    e. What happened to the volume of investment and the value of savings?

f. What happened to government incomes and expenditures?

g. What were the impacts on the structure of production?

An example of how we ran this experiment is in the file `anar_t_expt_G1_2_sol.inc` that is in the directory `4_expts`. You can compare this file with your version; we use the programme WinMerge which is a freeware file comparison programme, but you can use your preferred comparison software, e.g., the compare facility in MS Word.

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5. Project G1.1 Price and Accounting Relationships

It is important to understand how data in the SAM are used in the CGE model. The country SAMs used in this module can be found in the `input.gdx` file which you generated in Exercise G1, see the parameter `SAMG(sac,sacp,r)`. You can also find the SAMs in the data file samg_4_4_2_glb_t_*.gdx, see the parameter `NEWSAM(sac,sacp,r)`. (Note that the data in `SAMG` differs from the data in `NEWSAM` due to scaling.) You can export the SAMs to Excel from either *.gdx file to complete this project.

Review the SAM for the regions ROW and OECD.

1. What is the value of exports of manufactured goods (`cmanu`), in world prices from ROW to the OECD?
2. What is the value of margin services that ROW provides?
3. What is the value of ROW's imports of natural resources (`cnres`) from Africa, valued *pwmfob*?
4. What is the total tariff revenue collected in ROW?
5. What are the export subsidies on agricultural exports (`cagri`) from ROW to the OECD?
6. What is the value of trade margins on imports of manufactured goods (`cmanu`) from ROW in the region ROW?
7. What is the value of manufacturing (`cmanu`) exports *fob* from OECD to ROW?
8. What is the value of manufacturing (`cmanu`) exports from OECD to ROW in domestic prices, $PER_{cmanu,wrow,oecd} * QER_{cmanu,wrow,oecd}$?
9. What is the world price of manufacturing (`cmanu`) exports, *fob*, from OECD to ROW, $PWE_{cmanu,wrow,oecd}$?
10. What is the value of manufacturing (`cmanu`) imports *pwmfob* in ROW from OECD?
11. What is the value of manufacturing (`cmanu`) imports *cif* in ROW from OECD?
12. What is the domestic price of imports in ROW from OECD, $PMR_{woecd,cmanu,row}$?

6. Ex G1.3: Policy Experiments with Save and Restart

The previous exercise implemented a free trade agreement (FTA) experiment by extending the core model file, `anar_t.gms`. This a perfectly acceptable method but with large and/or complex models, in circumstances where a series of experiments using one core model are run and when building up experiment files this method can be time inefficient. GAMS provides a system whereby workfiles can be saved and then used to restart a programme. In this exercise we will use that facility to run the FTA experiments from Exercise 11.2.

When using the Save and Restart facility we recommend using command line instructions rather than using `Default GAMS Configuration` options. This is because we have found that running the core model and experiments in different projects, although with all the required files in one directory, is an efficient option. It is this option that we will use in this course.

1. We will continue to work in the directory `C:\cgemod\anar_t\anar_t1`. To be sure we have the same starting point, we will use our solution for G1.2, `4_expts_anar_t_expt_1_2_sol.inc`, that is already in your working directory. This is to ensure that the codes for this exercise are those expected, and means that we can pre-code the experiment file (see below)
2. All the files you need are already in the current project's directory.
3. Open the file `anar_t.gms`. In the section `POLICY EXPERIMENTS` comment out the experiment file that you created for Exercise G1.2, i.e., comment out all the code in this section. You may find it convenient and quicker to delete the section; but if you do so make a copy of the section first and save the copy.
4. In the file `anar_t.gms` add the instruction **`s=save`** in the command line and run `anar_t.gms`. This should run for a single solution, i.e., the replication of the base data.
5. Inspect the working directory. You should find a file `save.g00`.
6. Using `File>Open in a New Project` and open the file `anar_t_expt.gms`. You will now have 2 projects visible in the project explorer pane, each with a `Main File`.
7. The file `anar_t_expt.gms` has been precoded for this exercise.

8. The key components of `anar_t_expt.gms` are the code lines used in the Policy Experiments section for Ex G1.1, i.e., (explanatory text has been removed to save space)

```
*#### SETTINGS FOR EXPERIMENT AND RESULTS FILES
* Set dimensions for the results analysis files
$SETGLOBAL res_dimen      sim
* Set experiment File
$SETGLOBAL expt_inc       anar_t_expt_G1_2_sol
* Set experiment name for results
$SETGLOBAL expt_res       trade
* Set experiment data
$SETGLOBAL expt_data      data_anar_t_expt_G1_2_sol

*~~~~~~~ SELECT THE EXPERIMENT FILE ~~~~~~~~~~~~~~~~~~~~~
* Experiment file
* A simple FTA policy scenario
$INCLUDE 4_expts\%expt_inc%.inc

*############### 18. RESULTS ANALYSES FILE ################

$INCLUDE 5_Analysis\anar_t_anal.inc
```

8. The key features include
   a. The $SETGLOBAL instructions identifies the name of the experimen data file, i.e., `data_anar_t_expt_G2_sol`, the name of the experiment include file `anar_t_expt_G1_2_sol.inc`, the labels for the result parameters, in this case `sim`, and the sub directory, `trade`, for the results.
   b. The INCLUDE command calls in the experiment file, i.e., `4_expts\%expt_inc%.inc`. When the model is compiled, this will read as `4_Expts\anar_t_expt_G1_2_sol.inc` , and
   c. switch on the `$INCLUDE 5_analysis\anar_t_anal.inc.`
9. In the project director `6_results` add a subdirectory `trade`.
10. In the command line of `anar_t_expt.gms` add `r=save`, which instructs the programme to restart using the file `save.g00`.
11. Rerun the model using `F10`.

The results should be identical to those from Exercise G1.2. Check some of the levels results to verify this is the case.

7. Ex G1.4: Accessing ANARRES Model Results

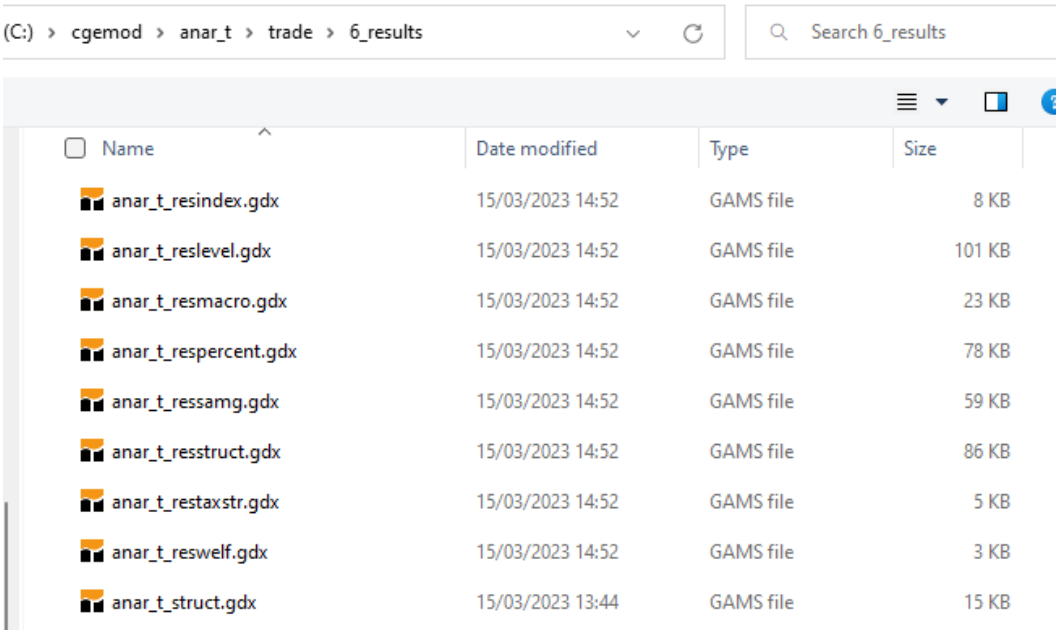
> *In this exercise we use GAMS Studio for accessing results in *.gdx files. We will explore different filtering options to view results and export them to Excel. Nothing you do will change the contents of the gdx files; there is not a right or wrong way to present the results, it is about what works for your audience, primarily, and for the user is very much a secondary consideration.*

Creating a CGE model and generating policy experiments is a means to an end rather than an end. The aim of the process is to generate results that provide information about the experiments, while the objective is to use the results to understand the implications of different policy objectives. A critical component of analysis with a CGE model is the production of results that make it easier for the analyst to explain the implications of the results and the causal factors driving the results.

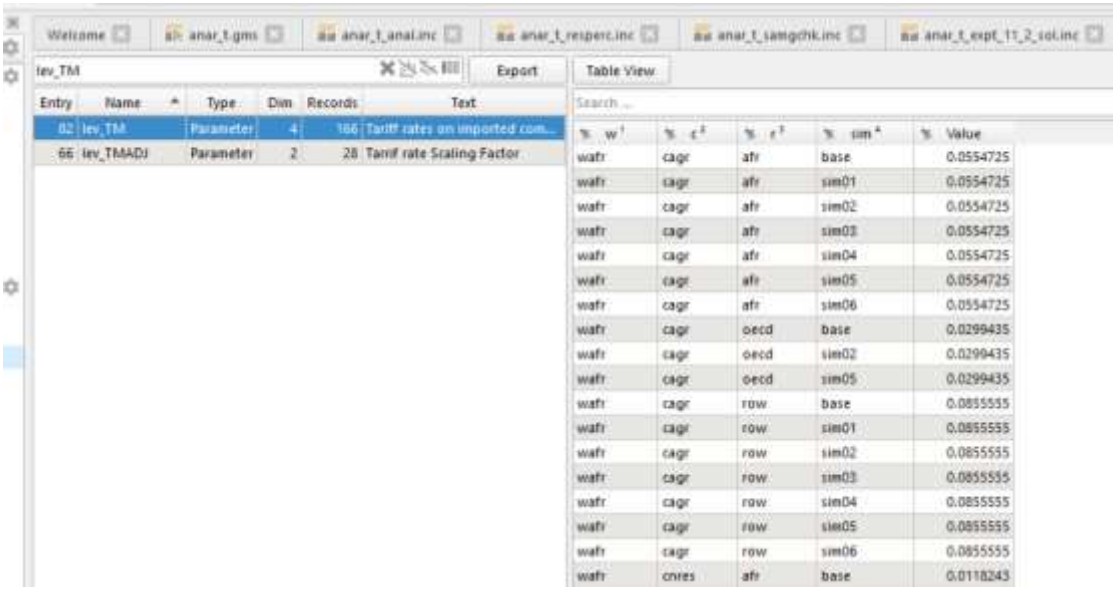
This exercise (G1.4) makes use of several print files, i.e., files that conduct post experiment calculations, to provide more information.

1. We will continue to work in the directory `C:\cgemod\anar_t\anar_t1`. To be sure we have the same starting point, we will use save and restart with `anar_t.gms` and `anar_t_expt.gms` and the example experiment file `anar_t_expt_G1_2_sol_2.inc`. The files are already in your working directory.
2. If you have cleaned your working directory after Ex G1.3 you will need to rerun the programmes to generate the required results files: make sure the command `$INCLUDE 5_Analysis\anar_t_anal.inc` is not commented out.
3. Check the results have been written out to the (sub) directory '`6_results\trade`'. You should find the following files with results: `anar_t_reslevel.gdx`, `anar_t_resmacro.gdx`, `anar_t_respind.gdx`, `anar_t_respercent.gdx`, `anar_t_resstruct.gdx` and `anar_t_reswelf.gdx`. (Note, there is a file `anar_t_struct.gdx` in the `6_results` directory, it was created when the base model ran, and it has information about the structure of the base model.)

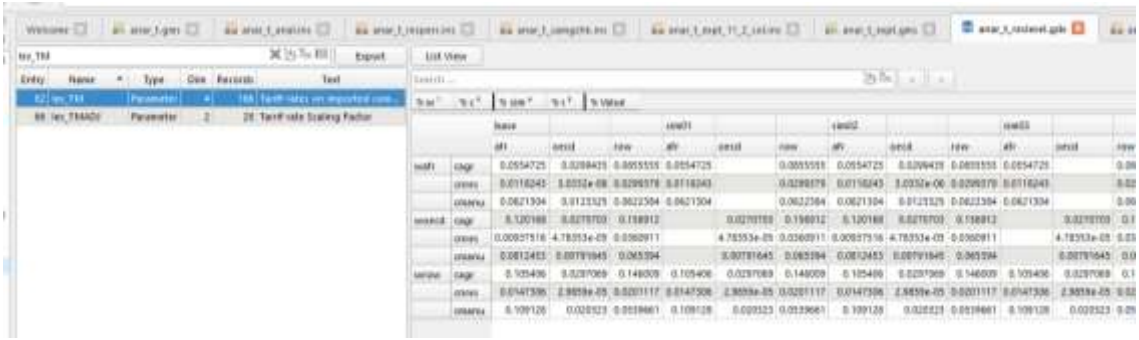
4. We will access results by opening the `*.gdx` files with results in GAMS Studio. We can filter the results and export the file to Excel. In GAMS Studio, search for `*.gdx` files in the subdirectory `6_results`. Since `*.gdx` is not the default, you will need to change the file type to `*.gdx`.



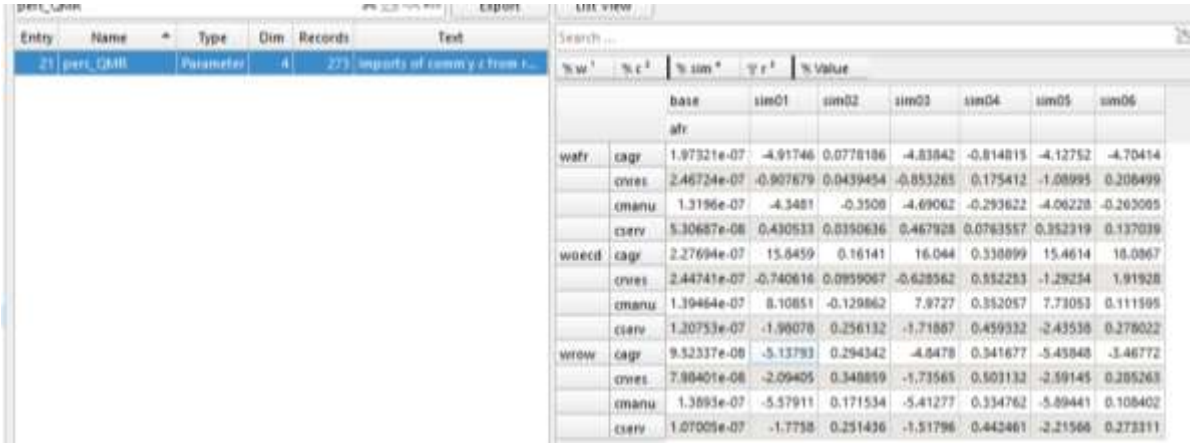
5. First verify that the shock you intended to run has been implemented (recall, checking the file `anar_t_shocks.gdx` is not sufficient because even if the shock parameters are correctly calibrated, they may not have been properly implemented in the code). Select the file `anar_t_reslevel.gdx` and select `lev_TM(c,r,sim)`. Note, there are **three** indices on which to filter. Your screen should look as follows; we recommend that you select an appropriate number of decimal places to display.



6. There are many ways to filter the results, you will need to explore the options and decide the presentation that works best for you. If you want to change the filtering and restart from the original presentation, you can select the "`reset`" button. The screen capture below illustrates one way to organize the results. The results indicate that the region `afr` for commodity `cagr` in the `base` has a tariff rate of 0.06 on imports from the region `wafr`, 0.12 on the region `woecd` and 0.11 on the region `wrow`. Review the `sims` you calibrated. Are the tariff levels reported for each `sim` in `anar_t_reslevel.gdx` consistent?



7. Filter the GDX view to compare the bilateral tariffs for the commodity `cagr` levied by all regions.
8. In GAMS Studio open the file `anar_t_respercent.gdx`. Review `perc_QMR`, the percent change in imports by partner. You will find that Africa's imports of agriculture from OECD increase by 15.85% and Africa's imports of agriculture from ROW decrease by 5.14% in `sim01`.



Entry	Name	Type	Dim	Records	Text
21	pert_QMR	Parameter	4	273	imports of comm y r from r...

		base	sim01	sim02	sim03	sim04	sim05	sim06
		afr						
wafr	cagr	1.97321e-07	-4.91746	0.0778186	-4.83842	-0.814815	-4.12752	-4.70414
	cnres	2.46724e-07	-0.907679	0.0439454	-0.853265	0.175412	-1.08995	0.208499
	cmanu	1.3196e-07	-4.3481	-0.3508	-4.69062	-0.293622	-4.06228	-0.263065
	cserv	5.30687e-08	0.430533	0.0350636	0.467928	0.0763557	0.352319	0.137039
woecd	cagr	2.27694e-07	15.8459	0.16141	16.044	0.338899	15.4614	16.0867
	cnres	2.44741e-07	-0.740616	0.0959067	-0.628562	0.552253	-1.29234	1.91928
	cmanu	1.39464e-07	8.10851	-0.129862	7.9727	0.352057	7.73053	0.111595
	cserv	1.20753e-07	-1.98078	0.256132	-1.71887	0.459332	-2.43538	0.278022
wrow	cagr	9.52337e-08	-5.13793	0.294342	-4.8478	0.341677	-5.45848	-5.46772
	cnres	7.98401e-08	-2.09405	0.348859	-1.73565	0.503133	-2.59145	0.285263
	cmanu	1.3893e-07	-5.57911	0.171534	-5.41277	0.334762	-5.89441	0.108402
	cserv	1.07005e-07	-1.7758	0.251436	-1.51796	0.442461	-2.21566	0.273311

9. To present the results in a graph or table, you will need to export them to Excel.

8. Project G1.2 Summarising Model Results

Compile a series of summary measures of the effects of the FTA on ALL regions. Specifically identify and explain the meaning of the following (HINT: you will need to look at the code to understand how these summary measures have been computed and use the appropriate `*.gdx` file in the results folder):

1. Changes in real and nominal GDP (expenditure measure (C + I + G + X – M)).
2. Changes in real and nominal Absorption.
3. Change in the nominal exchange rate.
4. Changes in aggregate real import and export values.
5. Changes in real and nominal private consumption.
6. Changes in household welfare (EV measure).
7. Changes in regional welfare (Slutsky measure).

Compile tables or graphs that demonstrate

1. How import prices for Africa change.
2. How import volumes (*QMR*) for Africa change.
3. How export prices for OECD change.
4. How factor demands by activities change in Africa.
5. How export volumes in the Rest of the World change.

In each case derive an explanation of why these results emerge. Remember it is never enough to just report the results; we always need to be able to explain the results. Your report should be a maximum of 5 pages including tables and graphs.

9. Note on Trade Taxes and Trade 'within' Regions

Intra-Regional Trade Transaction

There is an apparently odd feature to model databases derived from the GTAP database, especially when aggregate regions are created. An examination of the database, even in the fully disaggregated version from GTAP, shows that regions trade with themselves, i.e., region '*abc*' simultaneously imports from and exports to region '*abc*'. In the fully disaggregated version of the GTAP database this is primarily evident in those regions with labels starting with '*x*', i.e., '*x***': this is because those regions are aggregates of groups of countries. However, this is also found for some regions that are seemingly a single country; but an examination of the details about the regions demonstrates that some regions are aggregates, e.g., France contains Guadeloupe, Martinique and Reunion (see https://www.gtap.agecon.purdue.edu/databases/regions.aspx?), so intra region trade is to be expected.

In the context of global CGE models, regions, even aggregate regions, trading with themselves may seem anomalous, and that deleting such trade transactions would be appropriate since the exports *fob* from a region to itself are identical to imports *fob* from itself. Indeed, deleting such trade transactions would leave other transactions in the SAM unchanged except for some totals and the international trade margins. But, in a model deleting such transactions will have effects; specifically, the bilateral trade **value shares** would be changed. If the trade shares by value change, then so must the share and shift parameters in the trade aggregation (CES and CET) functions. This will impact on the results through the associated changes in behavioural response, NB: the behaviour of aggregation functions depends on both the elasticities and the shares. Moreover, if intra-regional trade transactions are deleted the behaviour of the model will depend, more than is the usual case, on the chosen aggregation.

A common practice is therefore to retain the trade transactions that report intra-regional trade. The ANARRES model follows this practice.

Intra-Regional Trade Taxes

If the intra-regional trade transactions were to be eliminated it would also be necessary to delete the associated trade taxes – import duties and export taxes – and international trade margins.

Deleting the trade taxes is problematic; it will change the prices of imported goods and services, thereby requiring re-estimation of purchaser prices, and reduce government revenue. Moreover, the existence of trade taxes between countries within (aggregate) regions (should) indicate the existence of trade barrier between the countries: deleting the trade taxes will distort the system and model results.

But when trade taxes on intra-regional trade are left in the database it is important to recognise their existence so to avoid changing intra-regional trade relations and thereby distorting inter-regional trade relations.