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ANARRES

ANARRES_t Model Overview



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Outline

- Basic principles
- Processes
 - Data assembly and model adjustments
 - Data – from GTAP in a SAM
 - Model – anar_t
 - Loading data
 - \$SETGLOBAL
- Policy Analyses
 - ‘Backstory’ and policy scenarios
 - Implementing policy simulations
 - Analyse results
- Running the model
 - Run with GDX Creation
 - Generate reference files
 - Use Save and Restart
- Model Structure
 - Singleton sets
 - \$SETGLOBAL
- Notation
- Agents in the model



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Basic Principles

- R region models linked through trade
 - SMOD_t +
- Data
 - GTAP +/- (v8)
 - SAM based
- Modular
 - Group actions in discrete modules
 - Data entry
 - Parameter calibration
 - Variable initialisation
 - Equation declaration and assignment
 - Closure
- Separation of core model and simulations



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Project

Ex G1.5

Ex G1.1

Ex G1.1-7

Ex G1.6

Ex G1.7

Ex G1.2

Ex G2.8

Ex G1.8

Ex G1.3

Create Database

Generate Aggregation

Set up ANARRES version

Adjust ANARRES version

Verify ANARRES version

Calibrate ANARRES version

Generate Experiment Data

Code Experiment File

Determine Macro Closures

Determine Market Clearing

Run Experiments

Check Shocks

Generate Results

Sensitivity Analyses

Set up Data Definitions

Analyse Results

Source: GTAP Database

SAMgator

data_C_F_R.xls; samg_C_F_R.gdx

anar_t.gms

CHECK model status

CHECK model status

Assemble data for policy shocks

code policy shocks

anar_t_el_**.inc

anar_t_el_**.inc

anar_t_expt_**.gms/inc

DISPLAY and GDX output

anar_t_expt_**.gms/inc

anar_t_DataDef_**.xls

GDX (and SecResults.xls)

Processes

Data assembly & Model adjustments

'Backstory' and Policy Scenarios

Implement Policy Simulations

Analyse Results

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Data Assembly and Model Verification



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Data assembly & Model adjustments

Create Database

↓

Generate Aggregation

↓

Set up ANARRES version

↓

Adjust ANARRES version

↓

Verify ANARRES version

↓

Calibrate ANARRES version

↓

Source: GTAP Database

SAMgator

data_C_F_R.xls; samg_C_F_R.gdx

anar_t.gms

CHECK model status

CHECK model status

1. GTAP in a SAM

2. SAM Aggregation

3. Data_4_4_3.xls ; samg_4_4_3.gdx

4. ANARRES_t

5. Exercises



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ANARRES Regional SAM

	Com'dities	Activities	Factors	Private H'hold	Taxes	Govt	Invest	RoW	Globe
Commodities		Int'diate Inputs		Private demand		Govt Demand	Invest demand	Exports (fob)	Margin Exports
Activities	Supply								
Factors		Factor payments							
Private H'hold			Factor incomes						
Taxes	Product taxes	Activity Taxes	Factor taxes						
Govt				Income Taxes	Tax revenue				
Savings			Dep'tion	Savings		Savings		Trade balance	Margin Trade balance
RoW	Imports (fob)								
Globe	Margins								

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ANARRES_t Africa SAM

sagr	cnres	crman	cserv	asagr	lanres	amman	aserv	fland	fcap	fltskl	fskl	lma	lmoe	lmrow	lcafr	lcoccc	lcrow	fland	fcap	fltskl	fskl	lwafr	lwatp	lwafr	lwoccc	lwrow	lwgo	HOU	SALT	PROD	DIRT	Govt	l	s	TOTA		
sagr	0	0	0	0	###	78	###	8,694	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,887	###	7,625	0	###	0	0	0	102	3607	###	
cnres	0	0	0	0	27	7,862	###	1,402	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,811	###	###	0	1,139	0	0	0	1	189	###	
crman	0	0	0	0	###	###	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	###	0	0	0	0	###	###	###		
cserv	0	0	0	0	###	###	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,570	###	###	6,583	###	0	0	0	###	###	
asagr	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
lanres	0	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
amman	0	0	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
aserv	0	0	0	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
fland	0	0	0	0	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
fcap	0	0	0	0	###	###	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
fltskl	0	0	0	0	###	###	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
fskl	0	0	0	0	958	3,251	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
lmafr	179	90	2,458	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2727		
lmoe	1,118	22	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
lmrow	657	202	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
lcafr	0	35	866	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	900		
lcoccc	0	433	1,063	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1496		
lcrow	0	343	453	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	796		
fland	0	0	0	0	298	964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1262		
fcap	0	0	0	0	508	1,653	1,673	5,539	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7373	
fltskl	0	0	0	0	2,191	417	2,599	4,020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9137	
fskl	0	0	0	0	20	72	513	3,018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3624	
lwafr	346	781	2,633	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3760		
lwatp	819	225	8,194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9238		
lwoccc	545	901	8,133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9580		
lwrow	2,887	6,811	###	1,570	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###		
lwgo	8,488	2,089	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
HOU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
SALT	779	-5	###	8,022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
PROD	0	0	0	0	1,263	4,220	###	###	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###
DIRT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
Govt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	###	
TOTA	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###	###

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Exogenous Data

- Elasticities
 - Armington (imports)
 - Top and second level
 - CET (exports)
 - Top and second level
 - Production
 - Top level (QVA/QINT)
 - Second level (Aggregate value added)
 - Consumption
 - Income elasticities of demand
 - Frisch parameter



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Satellite Accounts - GTAP

- Energy use data
 - Volumes (mtoe)
- Emissions
 - CO₂, N₂O, CH₄, F-gases
- GMig2
 - Migration and remittances
- Factor quantities
 - Labour
 - Land areas
- Land Use
 - GHG emissions
- Biofuels
 - Ethanol, etc



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Model Structure



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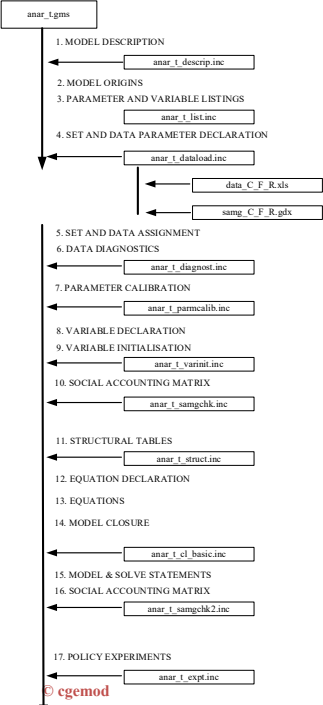
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Model – Code Structure

- Documented
- Number of ‘include’ files
 - Reference file
- Concentration of data input
 - An Excel workbook
 - A GDX file
- Extensive model verification
 - Aborts, with error messages, if tests fail



```
graph TD;
    main[amar_t.gms] --> 1[1. MODEL DESCRIPTION  
amar_t_descrip.inc];
    main --> 2[2. MODEL ORIGINS];
    main --> 3[3. PARAMETER AND VARIABLE LISTINGS  
amar_t_list.inc];
    main --> 4[4. SET AND DATA PARAMETER DECLARATION  
amar_t_datload.inc];
    main --> 5[5. SET AND DATA ASSIGNMENT];
    main --> 6[6. DATA DIAGNOSTICS  
amar_t_diagnost.inc];
    main --> 7[7. PARAMETER CALIBRATION  
amar_t_parmcalib.inc];
    main --> 8[8. VARIABLE DECLARATION];
    main --> 9[9. VARIABLE INITIALISATION  
amar_t_varinit.inc];
    main --> 10[10. SOCIAL ACCOUNTING MATRIX  
amar_t_samgchk.inc];
    main --> 11[11. STRUCTURAL TABLES  
amar_t_struct.inc];
    main --> 12[12. EQUATION DECLARATION];
    main --> 13[13. EQUATIONS];
    main --> 14[14. MODEL CLOSURE  
amar_t_cl_basic.inc];
    main --> 15[15. MODEL & SOLVE STATEMENTS];
    main --> 16[16. SOCIAL ACCOUNTING MATRIX  
amar_t_samgchk2.inc];
    main --> 17[17. POLICY EXPERIMENTS  
amar_t_expt.inc];
```

1. MODEL DESCRIPTION
amar_t_descrip.inc
model data & behaviour description

2. MODEL ORIGINS

3. PARAMETER AND VARIABLE LISTINGS
amar_t_list.inc
alphabetic listing

4. SET AND DATA PARAMETER DECLARATION
amar_t_datload.inc
data include file

data.C.F.R.xls
Excel sets and data file

samg.C.F.R.gdx
GDX data file

5. SET AND DATA ASSIGNMENT

6. DATA DIAGNOSTICS
amar_t_diagnost.inc
data diagnostics file

7. PARAMETER CALIBRATION
amar_t_parmcalib.inc
Parameter declaration and calibration file

8. VARIABLE DECLARATION

9. VARIABLE INITIALISATION
amar_t_varinit.inc
Variable initialisation file

10. SOCIAL ACCOUNTING MATRIX
amar_t_samgchk.inc
MacroSAM & MicroSAM check on calibration

11. STRUCTURAL TABLES
amar_t_struct.inc
Descriptive structural tables

12. EQUATION DECLARATION

13. EQUATIONS

14. MODEL CLOSURE
amar_t_cl_basic.inc
Base model closure

15. MODEL & SOLVE STATEMENTS

16. SOCIAL ACCOUNTING MATRIX
amar_t_samgchk2.inc
MacroSAM & MicroSAM check on model

17. POLICY EXPERIMENTS
amar_t_expt.inc
Experiment files

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Model Code – Data Entry

4. SET AND DATA PARAMETER DECLARATION

anar_t_dataload.inc

data include file

data_C_F_R.xls

Excel sets and data file

samg_C_F_R.gdx

GDX data file

5. SET AND DATA ASSIGNMENT

6. DATA DIAGNOSTICS

anar_t_diagnost.inc

data diagnostics file

- Model data entry in one module (dat_C_F_R.inc)
- Data testing and automatic aborts
 - On entry (anar_t_diagnost.inc)
 - At calibration stage (anr_t_samgchk.inc)
 - At replication stage (anr_t_samgchk.inc)

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Model Code – Parameters & Variables

7. PARAMETER CALIBRATION

anar_t_parmcalib.inc

Parameter declaration and calibration file

8. VARIABLE DECLARATION

9. VARIABLE INITIALISATION

anar_t_varinit.inc

Variable initialisation file

10. SOCIAL ACCOUNTING MATRIX

anar_t_samgchk.inc

MacroSAM & MicroSAM check on calibration

11. STRUCTURAL TABLES

anar_t_struct.inc

Descriptive structural tables

- All parameters calibrated in one module (anar_t_parmcalib.inc)
- All variables initialised in one module (anar_t_varinit.inc)
- Check calibrated parameters and initialised variables are consistent with the data
 - anar_t_samgchk.inc
- Produce structural tables that describe initial state (anar_t_struct.inc)

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Core of the Model

12. EQUATION DECLARATION

13. EQUATIONS

14. MODEL CLOSURE

15. MODEL & SOLVE STATEMENTS

16. SOCIAL ACCOUNTING MATRIX

17. POLICY EXPERIMENTS

anar_t_cl_basic.inc

anar_t_samgchk2.inc

anar_t_expt.inc

Base model closure

Macro SAM & Macro SAM check on model

Experiment files

• Equations/Behavioural relationships

- Declaration
- Assignment

• Impose base closure (anar_t_cl_basic.inc)

• Check replicated solution is consistent with the data

- anar_t_samgchk.inc

• Implement policy experiments (anar_t_expt.inc)

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‘Backstory’ and Policy Scenarios

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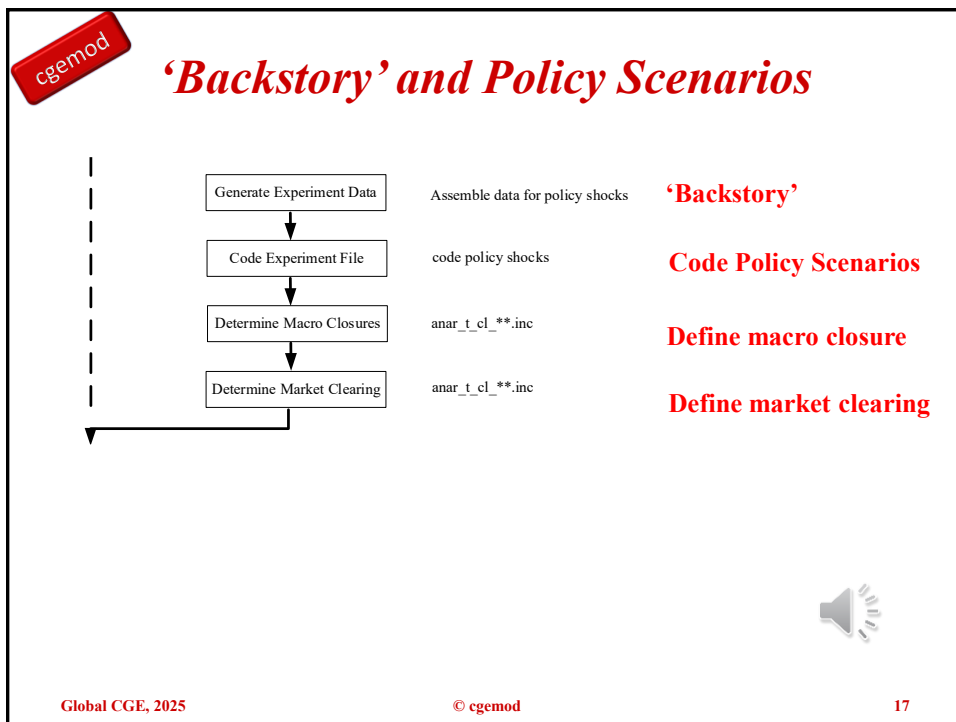
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Role of an Analyst

- Advice
 - Options; Implications; Information
- Legitimation
 - ‘*post hoc ergo propter hoc*’ (after this, therefore because of this)
 - Argument by analogy (It worked in ****)
 - Appeal to authority (The **** says this is best)

Aim: Understand how a system may operate and respond to policy changes

Objective: Provide information useful to policy makers



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‘Backstory’

- The economy(ies) being studied
 - Learn about the economy and the issue
- What is the policy issue being examined?
 - Is CGE the right method?
 - What is the time horizon?
- What are the economic environments?
 - Socio-politico-economic issues
- How do the economies operate?
 - Exchange rate regimes
 - Tax system options
- Responsiveness
 - Elasticities



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Policy Scenarios

- How should the policy issue be simulated?
 - Regime changes
 - Unilateral vv bilateral changes
 - Partial vv total changes
 - Simulation and reality are NOT identical
- How should the model be configured?
 - Macroeconomic closure
 - Sensitivity testing
 - Market clearing



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The Model

Do model and/or data need changing?

Behavioural issues: change the model

Data issues: change the database

It is (arguably) bad practice to change the data to fit the model

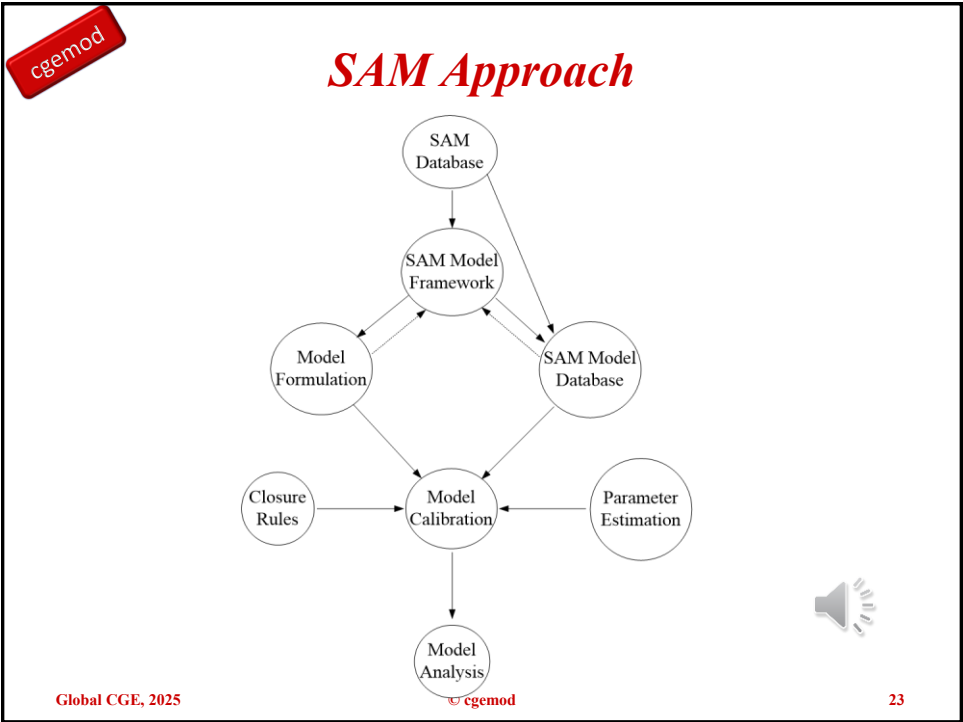


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‘Replicate’ v Experiment

‘Replicate’	Experiment
• Shocks – Set all indirect commodity tax rates to ZERO – Identify the VAT rate that the government should impose • Report – Identify the aggregate welfare gains associated with a ‘more efficient’ tax instrument	• Shocks – Remove each indirect commodity tax in turn – Analyse the implications of differential VAT rates – Analyse a range of alternative fiscal policy options, e.g., direct taxes, reductions in government expenditure, etc., • Report – Identify the household welfare effects associated with different combinations of tax instruments – Identify implications for other dimensions of the economy, e.g., competitiveness of activities

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Running the Model

- Run with GDX Creation
 - F10 (or Shift+F10)
- Generate reference files
 - Command line : rf=***
 - GAMS Configuration
- Cumulative errors
 - GAMS configuration
- Use Save and Restart
 - Command line : s=***
 - Command line : r=***



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Comparative statics



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Issues with Comparative Statics

- Comparative statics and ‘*manna from heaven*’
 - Avoid changing the future
 - Free goods from the future
 - **unrequited debts**
 - Technical changes
- Comparative Statics and Deficits
 - Reduce tax rates with flexible internal balance
 - Welfare enhancing because government deficit does not enter the welfare/absorption metrics
 - **debt passed to future generations**
- Comparative Statics and the Future
 - Reduce savings rates
 - Current consumption increases at the expense of future consumption
 - **capital stocks in the future decline**



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Simulation and Analyses



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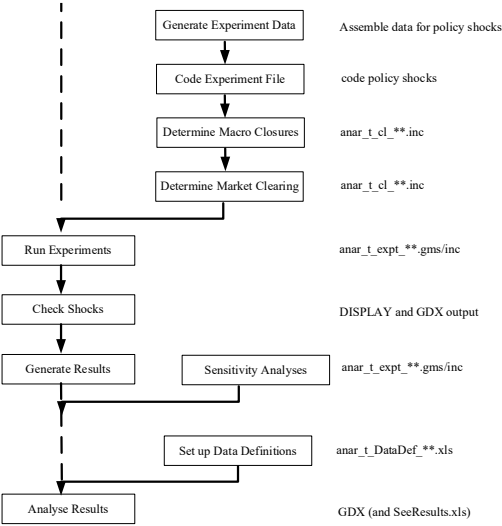
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Simulations and Analysis



```
graph TD; A[Generate Experiment Data] --> B[Code Experiment File]; B --> C[Determine Macro Closures]; C --> D[Determine Market Clearing]; D --> E[Run Experiments]; E --> F[Check Shocks]; F --> G[Generate Results]; G --> H[Analyse Results]; G --> I[Sensitivity Analyses]; I --> J[Set up Data Definitions]; J --> H;
```

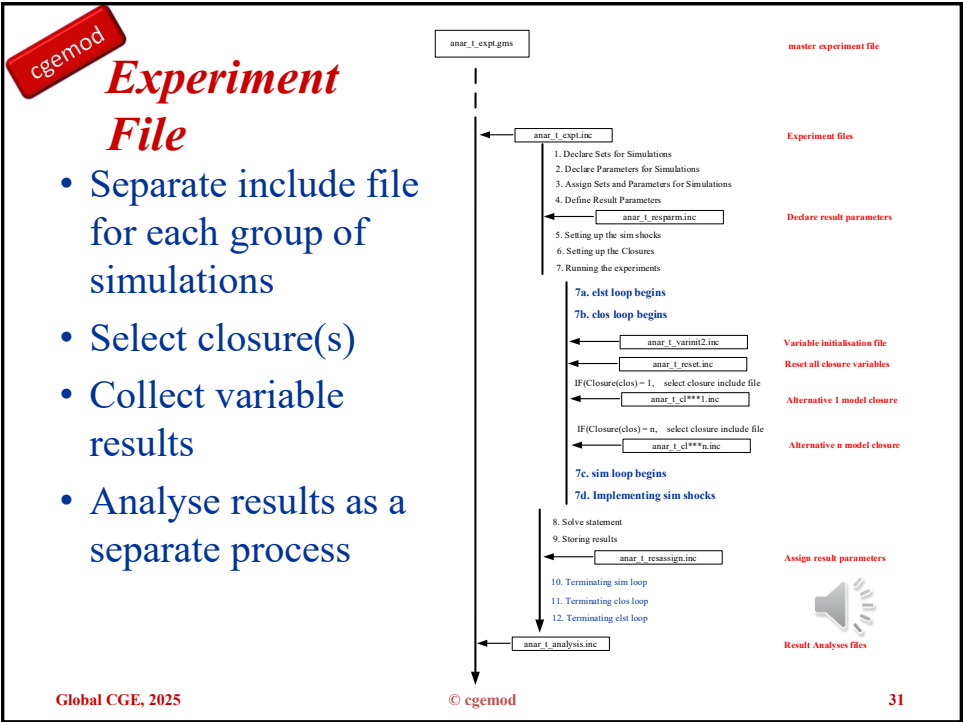
The flowchart illustrates the simulation and analysis process. It starts with 'Generate Experiment Data' (Assemble data for policy shocks), followed by 'Code Experiment File' (code policy shocks), 'Determine Macro Closures' (anar_t_cl_**.inc), and 'Determine Market Clearing' (anar_t_cl_**.inc). These steps lead to 'Run Experiments' (anar_t_expt_**.gms/inc), 'Check Shocks' (DISPLAY and GDx output), 'Generate Results' (anar_t_expt_**.gms/inc), and 'Analyse Results' (GDx (and SeeResults.xls)). 'Generate Results' also leads to 'Sensitivity Analyses' (anar_t_expt_**.gms/inc), which then leads to 'Set up Data Definitions' (anar_t_DataDef_**.xls), which finally leads to 'Analyse Results'. The process is divided into three main sections: 'Main focus' (Generate Experiment Data to Determine Market Clearing), 'Largely mechanical' (Run Experiments to Generate Results), and 'The hard bit – analyse do NOT just describe' (Sensitivity Analyses to Analyse Results).

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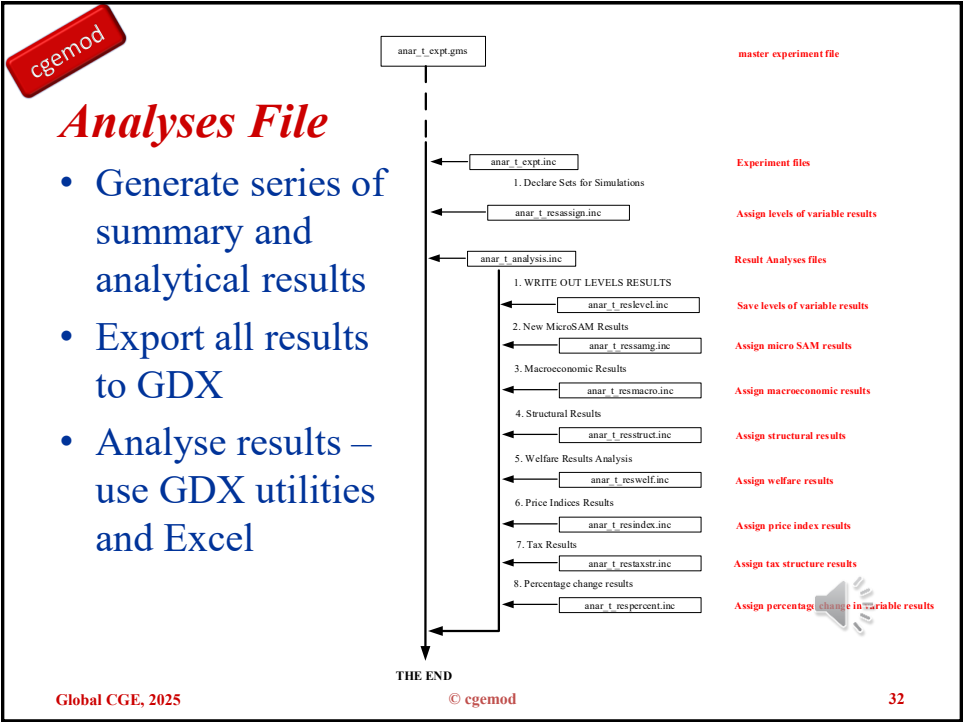
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Notation



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Notation

Set ordering – row, column, region

follows from the SAM basis

Accounts – based on GTAP sector, factor, and region labels

Prefixes used: c – commodities

a – activities

f – factors

h – households

t* – taxes

*tp – margins

w – trade partners

Set ordering in GAMS

- First use of a label dominates
- e.g., order of elements in *sac* determines order (in GAMS) of *c*, *a*, *f*, etc.
- Use of *#*:#***

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ANARRES_t Model: Overview

The End



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