

Practical Computable General Equilibrium (CGE)

Modelling: Online Course

Course Description

This course **introduces** practical computable general equilibrium (CGE) modelling using the General Algebraic Modelling System (GAMS) software. The course is designed for individuals who want to develop the theoretical and technical skills required to become advanced users of modern CGE models and/or independent CGE modellers. Participants need to have a well-developed background in economics, e.g., a masters, or higher, degree in economics or a closely related subject. The course emphasises an understanding of CGE databases, GAMS coding skills, the formulation of appropriate policy experiments and the interpretation of the results from simulation models; using a mix of video presentations (lectures and ‘how to’ videos), practical computer exercises and policy analyses exercises. This introductory course is a prerequisite for the intermediate Single Country and Global CGE Modelling course that are offered by CGEMOD; it can also be taken as a standalone course.

The materials are organised in 6 modules offered over 6 weeks, with support offered in a seventh week to allow for ‘slippage’). The first 5 modules have a total of 27 components, each of which requires approximately 3 hours of input from the participants. The final module of the course is devoted to a guided research project that requires about 12 hours of input. Thus, participants should allocate some 120 hours over 6 weeks to complete the course. Each module requires the participants to submit a deliverable; this allows the tutor to monitor progress and understanding.

The course assumes that the participants have an in-depth knowledge of microeconomic theory, especially general equilibrium theory, and a reasonable understanding of standard techniques of mathematical economics, especially those relating linear homogenous functions. It is assumed that participants have no prior computer programming experience, but that they do have basic computer skills associated with MS Excel.

Participants on this course are required to study a pre-course on GAMS and Social Accounting Matrices (SAMs). The pre-course materials are open source (see www.cgemod.org.uk/training.html for details), which allows potential participants to make a more informed decision before committing to take the course. Two weeks before this course, registered participants are provided with two sets of exercises to complete BEFORE the start of the course: the first exercise is on GAMS and GAMS Integrated Development Environment (GAMSIDE), and the second is on SAMs. The methods used in this course require a basic understanding of the mechanics of GAMS and a basic understanding of Social Accounting Matrices (SAMs).

Participants who do not complete the exercises before the start dates for the course will be offered a place on the next running of the course (see the timetable at www.cgemod.org.uk/ttable.html).

The course is delivered via an electronic learning environment – Moodle. Moodle provides an environment that allows the delivery of learning materials in a structured and organised manner, and an asynchronous forum in which participants can engage with other participants and with the course tutor. The course tutor is available, by email and/or the Moodle message system, to answer specific questions and provide help with problems: questions and requests for advice submitted between 0800 and 1600 UTC will be responded to by the end of the next working (Monday to Friday) day, i.e., by 1600 UTC. Each module requires the participants to submit an assignment; this allows the tutor to monitor progress and understanding, and to intervene if participants are not understanding concepts and techniques or having difficulties. Feedback is provided for each assignment.

This course does NOT use a GUI (Graphical User Interface) to access GAMS. Experience has demonstrated that the use of GUI's by participants on training programmes typically limits the development of the skills needed to be a good CGE modeller or user of CGE models, while encouraging the belief that CGE models are 'black boxes'. Basic GAMS programming skills, and an understanding of economic theory, demonstrates that allegations that CGE models are 'black boxes' are false. The development of GAMS, or GEMPACK, programming skills greatly extends the ability of the user to exploit the power of CGE models, and, at the same time, opens up the potential that participants can, in the future, change behavioural relationships in CGE models.

Course Aims and Objectives

Course Aims

To provide a practical introduction to CGE modelling using GAMS so that participants can understand

- i) databases used by CGE models;
- ii) the properties of behavioural relationships used in CGE models;
- iii) the formulation of appropriate CGE policy experiments; and
- iv) the results generated by simple CGE models.

Course Objectives

On completion of the course the participants will have the ability to:

- i) formulate and code appropriate policy experiments;
- ii) modify simple behavioural relationships;
- iii) interpret the results from simple CGE models; and
- iv) identify and understand the strengths and limitations of CGE models.

Course Models

This course uses three models that have been developed to provide training in CGE theory and techniques. The first model (clmod) is a simple closed economy model that converts the simple GE model of textbook economics into a computable GE model; it is inspired by the Shoven and Whaley approach. The second model (123) is a variant of the model developed by Robinson and various collaborators to demonstrate the theoretical and empirical properties of the approach (following Armington) to the modelling of trade in CGE models. The third model (SMOD) is a simple single country CGE model consistent with the state-of-the-art CGE models in the late 1990s. The SMOD model brings together the behavioural relationships used in the clmod and 123 models. All three models are organised in identical ways and use (largely) common notation and coding techniques.

The STAGE (www.cgemod.org.uk/stage.html) and GLOBE (www.cgemod.org.uk/globe.html) models are elaborations of the SMOD model.

Timetable

Online courses are run in four cycles – Oct/Nov, Nov/Dec, Jan/Feb and March/April – with recruitment for each course limited to c12 participants. This course will be offered in cycles 1, 2 and 3.

The timetables for courses are available at www.cgemod.org.uk/ttable.html

Course Fees

The course fees and conditions are detailed at www.cgemod.org.uk/fees.html

Discounts are offered for participants from developing countries ('Low-income economies' and 'Lower-middle-income economies' as classified by the World Bank) and students. Additional discounts are offered for participants who take multiple courses offered by CGEMOD.

A limited number of scholarships are available to students from developing countries. Applications for a scholarship must be made at the time of registration; applications must be accompanied by a case for being awarded the scholarship that is not longer than one-side of A4/US letter. Applicants must be registered at a degree awarding institution, correspond from an academic email address and provide confirmation of their status from an academic advisor.

Registration

Registration is online at www.cgemod.org.uk/regist.html

Further Information and registration

For further information please contact Professor Karen Thierfelder

Email: karen@cgemod.org.uk

Pre-Course

Outline

Module P1: GAMS and GAMSIDE

	Topic	Tasks	Exercises
P1:1	Introduction to GAMS and GAMSIDE	Install and configure GAMS/GAMSIDE; Running a Model; Using a model library	Setting options; libraries; utilities; help; search
P1:2	A Transport Problem in GAMS	Understanding a GAMS programme; Reference files; Command line; Running an experiment	running programme; list & log files; ref files;.gdx output
P1:3	Debugging a Transport Problem	Resolve syntax & execution errors; DiffText files	Debugging a model
P1:4	Extending a Transport Problem	Adding markets, plants & data	Adding accounts to a model

Readings:

Rosenthal, R.E., (1992). 'A GAMS TUTORIAL', in Brooke, A., Kendrick, D. and Meeraus, A., (1992). *GAMS: A User's Guide*, Scientific Press: San Francisco.

Module P2: Introduction to Social Accounting Matrices

	Topic	Tasks	Exercises
P2:1	What is a SAM?	Structure of a SAM; Contents of a SAM	Converting T-Accounts to a simple SAM
P2:2	Inter industry accounts in a SAM	Supply and Use tables; Input-Output tables	Interpreting the price system in a SAM
P2:3	Analysing a SAM	Interpreting a SAM	Row and column coefficients; interpreting SAMs
P2:4	SAM Multipliers	Income & Price multipliers; Interpreting multipliers	Multipliers; interpreting multipliers
P2:5	Satellite Accounts in a SAM	Adding satellite accounts	Interpreting satellite accounts

Readings:

Pyatt, G. and Round, J.I., (1977). 'Social Accounting Matrices for Development Planning', *Review of Income and Wealth*, 23(4), 339-364.

Stone, R., (1984). 'The Accounts of Society'. *Nobel Prize Memorial Lecture*

(http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1984/stone-lecture.pdf)

Round, Jeffery (2003). Constructing SAMs for Development Policy Analysis: Lessons Learned and Challenges Ahead. *Economic Systems Research* 15 (2): 161-183.

Practical CGE (Online) Course

Module O1: A Simple Closed Economy CGE Model

	Topic	Tasks	Exercises
O1:1	Cobb Douglas Production and Utility Functions	Mathematics of CD functions	Primal & first order conditions; calibrating shift & share parameters
O1:2 & O1:3	Coding Production and Utility functions	Adding production & Utility functions	Coding a basic 2*2*2*2; testing a model
O1:4	Simple CGE experiments	Running experiments; interpreting results	Running experiments; interpreting results
O1:5	Policy Analysis	Impact of changes in the factor supply	Interpreting results

Readings:

Microeconomics theory textbook with detailed treatment of general equilibrium (unfortunately many 'modern' textbooks do not provide comprehensive developments of GE economics), e.g.,

Gravelle, H. and Rees, R., (2004). *Microeconomics*, 3rd edition. Prentice Hall: London. Chapter 12, pp 250 - 278.

Nicholson, W., (1998). *Microeconomic Theory: Basic Principles and Extensions*, 7th Edition. Dryden Press: Fort Worth. Chapter 16, pp 459 – 500.

Shoven, J.B. and Whalley, J., (1984). 'Applied General Equilibrium Models of Taxation and International Trade: An Introduction and Survey', *Journal of Economic Literature*, Vol 22, pp 1007-1051.

Module O2: A Closed Economy CGE Models

	Topic	Tasks	Exercises
O2:1	Adding Government, Investment & Intermediate inputs	Coding taxes, investment & intermediate inputs; testing a model	Coding an extended 2*2*2*2; testing the model
O2:2	Tax experiments in a closed economy	Coding tax policy experiments	Tax experiments; interpreting results
O2:3	Using LOOPS in GAMS	Running experiments in LOOPS	Experiments in loops; interpreting results
O2:4	Tax experiments and factor market clearing	Coding compound experiments with different macro closures	Coding and interpreting compound experiments
O2:5	Collecting and interpreting results	Collecting results from experiments	Collecting and interpreting results
O2:6	Policy Analysis	Direct vv indirect taxes and alternative macro closure	Interpreting results

Readings:

Microeconomics theory textbook with detailed treatment of general equilibrium (unfortunately many 'modern' textbooks do not provide comprehensive developments of GE economics), e.g.,

Gravelle, H. and Rees, R., (2004). *Microeconomics*, 3rd edition. Prentice Hall: London. Chapter 12, pp 250 - 278.

Nicholson, W., (1998). *Microeconomic Theory: Basic Principles and Extensions*, 7th Edition. Dryden Press: Fort Worth. Chapter 16, pp 459 – 500.

Shoven, J.B. and Whalley, J., (1984). 'Applied General Equilibrium Models of Taxation and International Trade: An Introduction and Survey', *Journal of Economic Literature*, Vol 22, pp 1007-1051.

Module O3: 1*2*3 (Open Economy) CGE Model

	Topic	Tasks	Exercises
O3:1	CES and CET Functions	Primal & first order conditions;	Simple maths using CES
O3:2	The Basic 1*2*3 model	CES/CET functions in a simple CGE model with trade	Review 1*2*3 model
O3:3	Coding Trade with Imperfect substitution	Coding trade equations; calibrating CES/CET parameters; testing a model; running experiments	Coding import and export equations
O3:4	Understanding CES and CET functions 1	Role of elasticities in CES/CET functions; Offer curves	Change world price of imports; sensitivity to CES elasticity
O3:5	Understanding CES and CET functions 2	Role of elasticities in CES/CET functions; Dutch disease	Change trade balance; sensitivity to CES elasticity
O3:6	Understanding CES and CET functions 3	Role of trade shares in CES/CET functions; Offer curves	Changes to the world price of imports and change trade shares; sensitivity to CES elasticity

Readings:

- Armington, P.S., (1969). 'A Theory of Demand for Products Distinguished by Place of Production', *IMF Staff Papers*, Vol 16, pp 159-178.
- Benjamin, N., Devarajan, S. and Weiner, R., (1989), 'The 'Dutch' disease in a developing country: Oil reserves in Cameroon,' *Journal of Development Economics*, 30(1): 71–92.
- Devarajan, S., Lewis, J.D. and Robinson, S., (1990). 'Policy Lessons from Trade-Focused, Two-Sector Models', *Journal of Policy Modeling*, Vol 12, pp 625-657.
- Sen, A.K., (1963). 'Neo-classical and Neo-Keynesian Theories of Distribution', *Economic Record*, Vol 39, pp 53-64.

Module O4: 1*2*3 (Open Economy) CGE Model

	Topic	Tasks	Exercises
O4:1	An extended 1*2*3 Model	Adding government, investment, intermediate inputs and transfers from ROW to the simple 1*2*3 model	Review code with government, investment, intermediate inputs and transfers from ROW
O4:2	Changing country database	Assign a SAM for a different country in the model	Check that the model with new data is properly configured
O4:3	Analysis of trade policy change	Use Vietnam data/SAM	Develop and implement an experiment file for policy analysis
O4:4	Analysis of aid reduction	Use Ghana data/SAM	Develop and implement an experiment file for policy analysis

Readings:

- Devarajan, S., Lewis, J.D. and Robinson, S., (1990). 'Policy Lessons from Trade-Focused, Two-Sector Models', *Journal of Policy Modeling*, Vol 12, pp 625-657.
- Armington, P.S., (1969). 'A Theory of Demand for Products Distinguished by Place of Production', *IMF Staff Papers*, Vol 16, pp 159-178.
- Sen, A.K., (1963). 'Neo-classical and Neo-Keynesian Theories of Distribution', *Economic Record*, Vol 39, pp 53-64.
- de Melo, Jaime and Robinson, Sherman (1989). Product Differentiation and the Treatment of Foreign Trade in Computable General Equilibrium Models of Small Economies. *Journal of International Economics* 27 (1-2): 47-67.

Module O5: A Simple CGE Model

	Topic	Tasks	Exercises
O5:1	Introduction to SMOD	Model code & structure; data inputs & outputs; testing a model	Setting up and testing a simple CGE model
O5:2	Trade policy experiments 1	Coding policy experiments; interpreting model results	Coding and interpreting compound experiments
O5:3	Trade policy experiments 2	Sensitivity to elasticities; interpreting model results	Coding and interpreting results
O5:4	Trade policy experiments 3	Coding macroeconomic closures; interpreting model results	Coding and interpreting results
O5:5	Trade policy experiments 4	Coding factor market clearing; interpreting model results	Coding and interpreting results
O5:6	Trade policy experiments 5	Systematic sensitivity analyses	Interpreting results from systematic sensitivity analyses

Readings:

Pyatt, G., (1987). 'A SAM Approach to Modeling', *Journal of Policy Modeling*, Vol 10, pp 327-352.

Dahl, H., Devarajan, S. and van Wijnbergen, S., (1994). 'Revenue-Neutral Tariff Reform: Theory and an Application to Cameroon', *Economic Studies Quarterly*, Vol 45, pp 213-226.

Robinson, S., Yunez-Naude, A., Hinojosa-Ojeda, R., Lewis, J.D. and Devarajan, S., (1999). 'From Stylised to Applied Models: Building Multisector CGE Models for Policy Analysis', *North America Journal of Economics and Finance*, Vol 10, pp 5-38

Module O6: Course Project

The objectives of the project are to develop your ability to (i) set up and implement policy experiments in a small CGE model; and (ii) interpret the results of your policy experiments. There are five elements to the project; model recalibration, experiment programming, policy experiments and interpretation, sensitivity analyses and project report.

The available data are SAMs for (approx.) 15 countries, each of which has 12 commodities and activities, 5 factors, 7 taxes, 3 domestic institutions and 1 (one) rest of the world account.

Your remit is that of an economic consultant who has been employed to analyse policy issues that are relevant and current to your chosen country. You will be required to identify the policy issue, code the policy experiments, interpret and write up the results and conduct sensitivity analyses. The final report will be a maximum of 10 pages including tables and graphs.

	Topic	Tasks	Exercises
O6:1	SMOD Project	The project aims are <ol style="list-style-type: none"> 1. set up and implement policy experiments in a small CGE model; and 2. interpret the results of your policy experiments. 	There are five elements to the project; <ol style="list-style-type: none"> 1. model recalibration; 2. experiment programming; 3. policy experiments and interpretation; 4. sensitivity analyses; and 5. project report