

COURSE SYLLABUS

Computable General Equilibrium Modelling: Applications in Economy, Energy and Environment.

Fall 2015

ADMINISTRATIVE INFORMATION:

Schedule: Friday, 18:00-21:00

Dr. Paroussos Leonidas, Dr. Kostas Fragkiadakis

Course Description: This course will teach students Computable General Equilibrium (CGE) modelling. Students will learn to use the General Algebraic Modelling System (GAMS) software in order to formulate and solve small scale CGE models calibrated on Greek statistics. Objective of the course is to provide the student with the capability to design and quantify alternative policy scenarios in the fields of economics, energy and environment. Model applications including the evaluation of alternative fiscal policy measures, the implementation of GHG emission mitigation policies and the assessment of carbon leakage will be performed in order to illustrate the model properties and familiarise the student with the use of the modelling techniques.

The course will be structured around the development of a CGE model for Greece using the GAMS software. A specific to general teaching procedure will be adopted where the model building will start from scratch.

Audience: This course is intended for students who are interested in learning and applying CGE models to addressing current issues in fiscal and energy policies.

Requirements:

Students will be expected to prepare assignments for each lecture. Course grades will be based on model development assignments by 20% and final exam by 80%. The final examination will be computer based.

Material: Readings will come primarily from scientific Journal published articles (Energy Economics, Applied Economic Modelling, Economics Letters, Energy Policy etc.).

Course Outline

Lecture 1 Introduction to GAMS (basic syntax)

General rules, main operands, special symbols, structure of GAMS code, sets, scalars, tables, parameters, variables, equations, model declaration, solve statements, execution and compilation, GAMS output. Basic examples and introduction to programming.

Reading:

- 1) Richard E. Rosenthal, "GAMS | A User's Guide", 2013 GAMS Development Corporation, Washington, DC, USA

Additional material:

- 1) McCarl Expanded GAMS User Guide (available at www.gams.com/mccarl/mccarlhtml/)
- 2) Tom Rutherford's web page <http://www.mpsge.org/>
- 3) Wageningen University <http://www3.lei.wur.nl/gamstools/>

Assignment 1: Basic use of commands in GAMS.

Lecture 2 Formulating and Solving Optimization problems with GAMS

Formulation of optimization problems in mixed complementarity format. Solving linear and non-linear programming problems. Examples in GAMS.

Reading:

- 1) Alpha C. Chiang & Kevin Wainwright, "Fundamental Methods of Mathematical Economics" 2004, ISBN-10: 0070109109
- 2) Sven M. Flakowski, "Formulating and Solving Exhaustible Resource Models as Mixed Complementarity Problems in GAMS" Westfälische Wilhelms-Universität Münster Institute of Economic Theory

Additional material:

- 1) Sergey V. Paltsev, Moving from Static to Dynamic General Equilibrium Economic Models (Notes for a beginner in MPSGE), Department of Economics, University of Colorado, 2000

Assignment 2: LP, NLP and MCP optimization problems in GAMS.

Lecture 3: Leontief IO multipliers

Using the GAMS to compute Leontief IO multipliers type I and type II.

Reading:

- 1) D'Hernoncourt, J., Cordier, M., and Hadley, D., January, 2011, "Input-output multipliers specification sheet and supporting material", Université Libre de Bruxelles – CEESE, Brussels, University of East Anglia CSERGE, Norwich.

Assignment 3: Compute the IO multipliers type I and II for the Greek economy using the EUROSTAT SIOT 2010 table.

Lecture 4 A small static CGE model 2x2x2 in GAMS

Introduction in functional forms, single level and nested constant elasticity of substitution (CES) production functions and linear expenditure system (LES) utility function. Building a small static CGE model in GAMS with two commodities, two primary factors of production and two households. Running a reference and a counterfactual case with a tax imposed on capital use. Evaluation of the counterfactual case.

Reading:

- 1) Shoven and Whalley (1984): "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey", Journal of Economic Literature, 22, p.p. 1007-1051

Additional material:

- 1) Textbook of computable general equilibrium modelling: Programming and Simulations, by Nobuhiro Hosoe, Kenji Gasawa and Hideo Hashimoto, Palgrave macmillan, 2010.
- 2) Thomas F. Rutherford, Lecture Notes on Constant Elasticity Functions, University of Colorado, November, 2002

Assignment 4: Implementation of Small static CGE model in GAMS.

Lecture 5 Introduction to Databases and extension to a multi sector CGE model in GAMS

Representation of the Greek economy through a Social Accounting Matrix (SAM). Introduction to the GTAP Database and balancing methods (RAS, cross entropy).

Reading:

- 1) Pyatt and Round, 1985, "Social Accounting Matrices: A Basis for Planning", The World Bank.
- 2) Mansur, A. & Whalley, J, 1984, "Numerical specification of applied general equilibrium models: Estimation, calibration, and data", in Scarf, H.E., and Shoven, J.B. (Eds.), 1984, Applied General Equilibrium analysis, Cambridge, UK: Cambridge University Press.

Additional material:

- 1) Narayanan, G., Badri, Angel Aguiar and Robert McDougall, Eds. 2012. Global Trade, Assistance, and Production: The GTAP 8 Data Base, Center for Global Trade Analysis, Purdue University
- 2) Marcel P. Timmer (ed) (2012), "The World Input-Output Database (WIOD): Contents, Sources and Methods", WIOD Working Paper Number 10.
Available at <http://www.wiod.org/publications/papers/wiod10.pdf>

Assignment 5: A multi sector static CGE model in GAMS.

Lecture 6 A recursive dynamic CGE model in GAMS

Macro closure. Capital Stock motion equation. Investment function. Recursive dynamic. Drivers of growth (technical progress, population, agent expectations).

Reading:

- 1) Alpha C. Chiang, Elements of Dynamic Optimization, 1999, ISBN-13: 978-1577660965 ISBN-10: 157766096X
- 2) Hayashi, F. (1982). "Tobin's Marginal q and Average a: A Neoclassical Interpretation." *Econometrica*, Economic Society, vol.50 (1), 213-224.

Assignment 6: A recursive dynamic CGE model in GAMS.

Lecture 7 GHG emissions and Power Generation in CGE model in GAMS

EU Climate policy, Greenhouse gas (GHG) emissions and marginal abatement cost curves (MACC). Power generation technologies and bottom-up representation.

Reading:

- 1) Christoph Bohringer and Thomas F. Rutherford, "Combining Bottom-Up and Top-Down", 2007, Working Paper
- 2) Nicholas Z. Muller., The design of optimal climate policy with air pollution co-benefits, *Resource and Energy Economics* 34 (2012) 696–722
- 3) Jennifer Morris & Sergey Paltsev & John Reilly, Marginal Abatement Costs and Marginal Welfare Costs for Greenhouse Gas Emissions Reductions: Results from the EPPA Model, *Environmental Modelling Assessment* (2012) 17:325–336
- 4) Keigo Akimoto, Fuminori Sano, Takashi Homma, Kenichi Wada, Miyuki Nagashima and Junichiro Oda, "Comparison of marginal abatement cost curves for 2020 and 2030: longer perspectives for effective global GHG emission reductions", *Sustain Sci* (2012) 7:157–168

Assignment 7: Environmental module in GAMS.

Lecture 8 Introducing unemployment in CGE models

CGE models assume full employment in both capital and labour markets by default. This lecture will present alternative approaches in introducing involuntary unemployment in the CGE framework, including equilibrium unemployment, efficiency wages and Philips curve.

Reading:

- 1) Stefan Boeters, Luc Savard, "The Labour Market in CGE Models", 2011, ZEW - Centre for European Economic Research Discussion Paper No. 11-079

Assignment 8: Unemployment module in GAMS.

Lecture 9 Open Economy model

Small open economy assumption. Imperfect substitution between domestically produced and imported goods (Armington assumption). Endogenous bilateral trade.

Reading:

- 1) Armington, P.S. 1969, "A theory of demand for products distinguished by place of production". *International Monetary Fund Staff Papers*, vol. 16, 159–78.

Assignment 9: Open economy CGE model in GAMS.

Lecture 10: Model application: Alternative fiscal policies

Use the model to explore changes in VAT and the use of alternative public budget recycling options.

Reading:

1. Ramos Mabugu, Veronique Robichaud, Helene Maisonnave, Margaret Chitiga, Impact of fiscal policy in an intertemporal CGE model for South Africa, Economic Modelling, Volume 31, March 2013, Pages 775-782, ISSN 0264-9993, <http://dx.doi.org/10.1016/j.econmod.2013.01.019>.

Assignment 10: Expanding fiscal policy and alternative budgeting.

Lecture 11 : Model application: Internalising externalities GHG emission reduction

EU policy in GHG mitigation. Introduction of emission reduction constraints and carbon tax.

Reading:

1. Capros, P., Paroussos, L., Fragkos, P., Tsani, S., Boitier, B., Wagner, F., Busch, S., Resch, G., Blesl, M., Bollen, J., (2014), "European decarbonisation pathways under alternative technological and policy choices: A multi-model analysis", Energy Strategy Reviews, volume 2, issue 3-4, February 2014, pages 231-245.
2. Kriegler, E., Riahi, K., Bauer, N., Schwanitz, J., Petermann, N., Bosetti, V., Marcucci, A., Otto, S., Paroussos, L., Rao, S., Arroyo-Curras, T., Ashina, S., Bollen, J., Eom, J., Hamdi-Cherif, M., Kitous, A., Mejean, A., Schaeffer, M., Wada, K., Capros, P., van Vuuren, D., & Edenhofer, O., (2014), "Making or breaking climate targets: The AMPERE study on staged accession scenarios for climate policy" Technological Forecasting and Social Change, in press.

Assignment 11: GHG emission reduction simulation in GAMS.

Lecture 12: Model application: Estimation of Carbon Leakage.

Lack of consensus on an international agreement for reducing Greenhouse Gas Emissions (GHG) emissions eventually leads to asymmetric climate policies which not only increase the cost of reducing emissions but also decrease the effectiveness of the climate policy, through carbon leakage. We will calculate the carbon leakage rate when countries adopt unilateral climate policies.

Reading:

- 1) Paroussos L., Fragkos P., Capros P., Fragkiadakis K., (2014), "Assessment of carbon leakage through the industry channel: The EU perspective", Technological Forecasting and Social Change, in press.