Ruhr Graduate School in Economics
University of Duisburg-Essen
Essen, Germany, September 24-28, 2012

8th Ruhr Graduate Summer School

Trade and Climate Policy Analysis with GAMS and MPSGE

Instructors

Professor Dr. Christoph Böhringer, University of Oldenburg, Germany
Professor Dr. Volker Clausen, University of Duisburg-Essen, Germany

Objectives

Over the last decades computable general equilibrium (CGE) models have become a wide-spread tool for the economic impact assessment of policy regulation. The core of CGE analysis is the combination of general equilibrium theory with economic data to derive quantitative insights into the efficiency implications and distributional effects of policy measures.

This workshop provides a practical guideline to CGE modeling of open economies using the Global Trade Analysis Project (GTAP) dataset which includes detailed national accounts on production and consumption together with bilateral trade flows for a large number of countries. The workshop will discuss alternative approaches to study international trade in a general equilibrium framework: (i) the common Armington assumption that goods of different origin command different prices, (ii) the alternative notion of Heckscher-Ohlin that goods of different origin are homogenous, and (iii) Melitz's new trade theory of monopolistic competition among heterogeneous firms. Numerical models for these complementary approaches to policy analysis of open economies will be developed and applied to the fields of economic integration and climate policy.

For model implementation and data management we use the Generalized Algebraic Modeling System (GAMS) which is a convenient model language for the development of large-scale mathematical programs and the processing of extensive datasets.

The course will start with the fundamental conditions defining an economic equilibrium. Exploiting the complementarity features of economic equilibria we will formulate economic equilibrium problems as mixed complementarity problems to accommodate situations in which prices or quantities can drop to zero (e.g., trade reversal due to tariff changes). We initially demonstrate the attractiveness of the mixed complementarity approach vis-à-vis the standard formulation of economic equilibrium problems as a (nonlinear) system of equations along simple partial equilibrium models of global trade followed by general equilibrium extension to demonstrate the implementation of price rigidities (e.g., in the context of involuntary unemployment) and quantity constraints (e.g. in the context of equal-yield tax reforms). To gain policy-relevant insights applied (computable) equilibrium analysis involves the use of empirical data. We show how we can calibrate (parameterize) models to benchmark data (input-output table, social accounting matrixes, etc.) including the structural estimation of key elasticities such as Armington trade elasticities.

The thematic focus of the workshop is on trade and climate policy analysis. To provide the basis for subsequent large-scale applications we discuss and implement three alternative theoretical approaches to study international trade (Armington, Heckscher-Ohlin, Melitz) as well as standard extensions to represent greenhouse gas emissions, emission abatement possibilities and alternative climate policy regimes (emission taxes, standards, tradable permits). Pedagogic analysis based on small-dimensional models with stylized data will be complemented with large-scale applications based on the GTAP data set. We will explain in detail the structure of the GTAP data set and show how the data can be easily made amenable for trade and climate policy analysis in multi-sector, multi-region CGE models.

To facilitate the formulation and calibration of large-scale CGE models we introduce Rutherford's Mathematical Programming System for General Equilibrium analysis (MPSGE) – a wide-spread meta-language for CGE modeling. We discuss in detail the implementation of a generic multi-sector, multi-region CGE model based on GTAP data. The standard GTAPinGAMS trade model adopts the Armington assumption of product heterogeneity but we present alternative representations of trade in homogenous goods and monopolistic competition among heterogeneous firms. To investigate the economic implications of greenhouse gas control strategies the trade models will be extended with satellite energy flow and CO_2 emission data.

Applied policy analysis based on large-scale CGE trade models will comprise the impact assessment of trade reforms as well as the study of unilateral emission reduction policies complemented with border adjustment measures such as tariffs on embodied carbon to counteract emission leakage to non-abating trading partners.

The teaching technique we will follow consists of three steps repeated each half day: (1) a brief lecture, (2) examination and discussion of techniques via the use of simple template models, (3) exercises for the participants. Both instructors are available during the entire workshop.

Background of Instructors

Christoph Böhringer
University of Oldenburg

Prof. Dr. Christoph Böhringer is Professor of Economic Policy at the University of Oldenburg. His research for the last years has focused on the quantitative analysis of environmental and energy policies based on numerical optimization models. Since 1994, he has been regularly conducting workshops on applied analysis in the fields of environmental, energy, fiscal and trade policies. He has widely published in international journals, including *Applied Economics, Canadian Journal, Computational Economics, Ecological Economics, Energy Economics, Energy Journal, Energy Policy, Environmental and Resource Economics, European Economic Review, European Journal of Political Economy, Journal of Economic Dynamics and Control, Journal of Environmental Economics and Management, Journal of Policy Modeling, Journal of Regulatory Economics, Kyklos, Oxford Review of Economic Policy, The World Economy*.

Volker Clausen
University of Duisburg-Essen, Campus Essen

Prof. Dr. Volker Clausen is Professor of International Economics, University of Duisburg-Essen, Campus Essen since 2001. Previously he worked at the Universities of Kiel and Bonn in Germany and at Indiana University, in Bloomington, Indiana (USA). He holds a Ph.D. in Economics from the University of Kiel, Germany, and a Master of Science in Economics from the London School of Economics and Political Science. His current research interests include general equilibrium modelling with a focus on ageing in open economies and also in development economics. His publications have a focus on international topics and appeared in, among others, *Journal of International Money and Finance, Journal of Economic Integration and Review of World Economics*.

Course Coordinator

Zoryana Olekseyuk
University of Duisburg-Essen, Campus Essen

Workshop Topics and Schedule

Day 1: September 24, Monday

GAMS, Economic Equilibrium and Mixed Complementarity

- A short primer in GAMS
- Economic equilibrium and complementarity
- Partial equilibrium models of international trade
- *Hands-on session:* Alternative implementation of market equilibrium conditions as mathematical program, system of equations or a mixed complementarity problem (MCP)
- *Hands-on session:* Economic impacts of free trade agreements on commodity markets

Day 2: September 25, Tuesday

CGE Models – Structure, Functional Forms and Calibration

- Numerical implementation of a basic (Arrow-Debreu) general equilibrium model
- Micro-consistent dataset and model calibration to empirical datasets
- Incorporation of price and quantity constraints with applications to technology choice (activity analysis), involuntary unemployment and equal-yield tax reforms
- Models with scale economies and imperfect competition (monopoly, oligopoly, monopolistic competition)
- Nested functional (CES) forms
- *Hands-on session:* Algebraic implementation of template CGE models with benchmark taxes (replication check and techniques for debugging)

Day 3: September 26, Wednesday

Trade Modeling, GTAPinGAMS and MPSGE

- Open economy extensions: Heckscher-Ohlin and Armington assumptions, small open and large open economy settings, global trade models
- Trade policy analysis: tariffs and quotas
- GTAPinGAMS: The GTAP dataset and a generic multi-sector, multi-region model based on GTAP data
- Introduction to MPSGE – a meta-language for CGE modeling based on mixed complementarity and the calibrated share form for CES functions
- *Hands-on session*: Transformation of algebraic CGE models into equivalent non-algebraic MPSGE versions

Day 4: September 27, Thursday

Climate Policy Analysis

- GTAP-E: Extensions of the standard GTAP model to accommodate climate policy analysis
- Embodied carbon in traded goods: multi-region input-output (MRIO) calculations
- Emission leakage and implications for unilateral climate policy design: the case of border tariffs
- *Hands-on session*: Economic impact analysis of alternative climate policy regimes (gains from where-flexibility, implications of border carbon adjustments such as tariffs and rebates on embodied carbon)

Day 5: September 28, Friday

New Trade Theory – Implementation and Policy Applications

- Trade theories (Armington, Krugman, Melitz)
- General equilibrium implementation of alternative trade theories
- Policy applications to trade and emission regulation
- *Hands-on session*: Economic impact analysis of trade reforms and climate policies

Note: Depending on the previous experience of participants with GAMS, MPSGE and CGE modeling, the program might be covered more quickly at the beginning of the workshop which allows for more discussion and implementation of recent research toward the end of the workshop. This will be decided on the basis of the actual list of participants who will be asked about their previous experience in the field before the workshop starts.

Payment and Registration

The fee for participating in the training workshop is 2,500 Euro and includes lectures, course material and lunches. **Participants are required to bring a laptop with a DVD drive and adapters to German power supply if necessary.** The GAMS workshop license (valid for 2 months) as well as extensive course material will be provided on USB flash drives.

Academic participants from accredited universities or research institutions will be admitted on a space-available basis for a discount of 20%. Graduate students from accredited academic institutions are likewise admitted on a space-available basis for a discount of 50%. Please fax or email a copy of your student ID to get the discount. There will be a limited number of scholarships (*excluding travel and subsistence expenses*) that have been set aside for qualified participants from developing countries. Deadline for the application for a scholarship is **July 6, 2012**. Preference will be given to applicants who have documented previous experience in general equilibrium modelling with GAMS. To apply for a scholarship in the form of a tuition waiver, send your CV and a research paper via email to Zoryana Olekseyuk. A decision on the allocation of scholarships will be made until **July 13, 2012,** in order to allow for an early arrangement of flights, visa etc.

To register by phone, fax, or e-mail, contact:

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45117 Essen, Germany

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Fax: +49 (0)201-183-3974
email: rgss(at)vwl.uni-due.de

The registration deadline is **September 1, 2012**. The maximum number of participants is restricted to 16.
Slots are guaranteed only upon full payment of fees through the GAMS Course Coordinator. Cancellations will be fully refunded if made prior to **September 1, 2012**. No refunds will be made after the registration deadline.

Note the following disclaimer and limited liability: The program and the list of instructors are confirmed and correct at the time of publication. In case of any serious circumstances or acts of nature beyond control of the organizers, such as for example illness, death, cancellation of flights etc., the organizers aim for an adequate substitution. In the very unlikely, but still possible case, the maximum liability of the organizers is limited to the tuition. The organizers do not cover any other costs of the participants, such as travel bookings, visa fees etc.

Times and Location

Morning sessions will begin at 9am. Lunch is provided for workshop participants at noon. The afternoon sessions will run from about 1-4pm. Between 4 and 5 pm there will be time for further individual programming and consultation. All sessions take place in the Casino Gästehaus located in the east of the University of Duisburg-Essen, Campus Essen:

University of Duisburg-Essen, Campus Essen
Universitätsstraße 12
45117 Essen
Germany

Venue and Accommodation

Workshop participants must make their own arrangements for accommodation. The workshop will be held at the Department of Economics at the University of Duisburg-Essen, Campus Essen. Venue information will be provided after reservation.

Some rooms of category C have been earmarked until the **September 1, 2012** at:

Bildungshotel im Bfz-Essen e.V.
Karolingerstraße 93
45145 Essen, Germany
T: 0201/3204-243
F: 0201/3204-277
bildungshotel@bfz-essen.de
http://www.bildungshotel-essen.de/zimmer_e.htm

How to Prepare

No previous knowledge of GE modeling is assumed. Participants should be familiar with intermediate microeconomics and get acquainted beforehand with GAMS which is the (rather intuitive) programming language used for computer-based model implementation. Some introductory readings and a short do-it-yourself GAMS tutorial will be provided with further workshop information in mid-August 2012.

Workshop participants can do a number of things to prepare for the workshop. Here are some suggestions:

- Download the GAMS User's Guide.
- Download the Demonstration Version of GAMS. The GAMS software including a workshop license will be provided on the first day of the workshop.
- Study background material provided over the web, including the MPSGE home page at GAMS.