



Ruhr  
Graduate  
School  
in Economics

Ruhr Graduate School in Economics  
University of Duisburg-Essen

# *15th Ruhr Graduate Summer School*

UNIVERSITÄT  
DUISBURG  
ESSEN

*Open-Minded*

Essen, Germany

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## **ECONOMIC IMPACT ASSESSMENT OF ENERGY AND CLIMATE POLICIES USING GAMS AND MPSGE**

Instructors:

**Christoph Böhringer**

University of Oldenburg, Germany

**Volker Clausen**

University of Duisburg-Essen, Germany

## ➤ *Description*

Computer-based simulations to quantify the economic impacts of policy reforms play a key role in applied economic research. Among numerical methods, computable partial equilibrium (CPE) and computable general equilibrium (CGE) models are widely employed for sector-specific and economy-wide impact assessment. CPE and CGE models build upon equilibrium theory that combines assumptions regarding the optimizing behavior of economic agents with the analysis of equilibrium conditions. Quantitative equilibrium analysis provides counterfactual ex-ante comparisons, assessing the outcomes with a new policy reform in place against the business-as-usual situation.

The workshop develops step by step quantitative models that are used for the economic assessment of energy and climate policy initiatives. The course will follow model-based peer-reviewed publications in reputed international journals such as *The Energy Journal*, *Energy Economics*, *Journal of Regulatory Economics*, *Computational Economics*, or *Journal of Economic Dynamics and Control* to cover contemporary policy issues including

- support mechanisms (feed-in tariffs/premia, renewable portfolio standards) to electricity from renewable energy sources (RES-E)
- greenhouse gas emission regulation policies (emissions pricing and trading (EU ETS), emission floor price options, emission standards)
- environmental (green) tax reforms

The primary focus of the workshop will be on the detailed presentation and discussion of numerical simulation models that are underlying the quantitative policy analysis in these publications. Participants will thereby get familiar with state-of-the-art modeling approaches ranging from energy system models to integrated bottom-up/top-down models of the economy.

Mathematically the CPE and CGE models are formulated and implemented as “mixed complementarity problems” (MCP). The MCP formulation explicitly incorporates the feature of complementary slackness – i.e., complementarity between economic decision variables and associated economic equilibrium conditions – accommodating the comprehensive analysis of real world economic issues.

For the computer implementation of economic equilibrium models the course builds on the high-level programming language GAMS (Generalized Algebraic Modeling System) whose notation closely follows standard matrix algebra. The fundamental strength of GAMS lies in the ease with which mathematically-defined models can be formulated and solved. To facilitate the formulation of large-scale CGE models, we will use the Mathematical Programming System for General Equilibrium analysis (MPSGE) – a wide-spread meta-language for CGE modeling operational under GAMS.

Material and teaching is in English. Registered participants will receive the teaching material prior to the start of the workshop such that they can prepare in advance. Teaching will combine lectures on theoretical underpinnings of policy assessment with numerical model applications based on peer-reviewed publications.

**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 of Economics*, *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 Public Economics*, *Journal of Regulatory Economics*, *Kyklos*, *Oxford Review of Economic Policy*, *Scandinavian Journal of Economics*, or *The World Economy*.

**Volker Clausen**

University of Duisburg-Essen

Prof. Dr. Volker Clausen has been 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 open economies. His publications have a focus on international topics and appeared in, among others, *Economic Modelling*, *Journal of Economics and Statistics*, *Journal of Economic Integration*, *Journal of International Money and Finance* and *Review of World Economics*.

## ➤ *Workshop contents*

### **Part 1: Economic Equilibrium and Mixed Complementarity**

- Mixed Complementarity Problems (MCP)
- Optimization, mixed complementarity and economic equilibrium conditions

### **Part 2: CO<sub>2</sub> Emission Regulations**

- Economic cost of emission regulation based on sector- and region-specific marginal abatement cost curves
- Carbon price floor options in the European Union

### **Part 3: Electricity Markets – Overlapping Regulation**

- A cost-effectiveness analysis of alternative instruments to promote renewable energy production in the EU electricity market: green quotas, feed-in tariffs, and feed-in premia
- Overlapping regulation on electricity markets: the interaction of black and green quotas

### **Part 4: A Primer in General Equilibrium Modeling using MPSGE**

- Applied general equilibrium modeling (“Opening a black box”)
- Calibration of functional forms to observed empirical data
- Introduction to MPSGE: a meta-language under GAMS for implementation of (large-scale) CGE models
- Stylized CGE analysis of policy interventions

### **Part 5: Integrated BU-TD Analysis of Energy Policies – Green Tax Reforms**

- Integration of bottom-up electricity market models into top-down CGE models
- A decomposition method for combining bottom-up and top-down models in energy policy analysis

**Note:** The final schedule as well as coverage of aforementioned topics depend on the previous experience of participants with GAMS, MPSGE, and CGE modeling as well as on their specific research interests. Some parts might be covered more quickly at the beginning of the workshop which allows for more discussion and implementation of specific research requests by the participants later on. Participants will be asked about their previous experience in the field and their specific research projects prior to the workshop.

### ➤ *Target group*

The workshop is targeted to scientific researchers and policy analysts at universities, research centers, consulting companies and ministries that are interested in the economic impact assessment of policy interventions using numerical state-of-the-art models to investigate the economic impacts of energy and climate policies.

### ➤ *Your benefit*

The workshop provides you with state-of-the-art CGE modeling techniques. Application of these techniques will allow you to gain insights into economic theory with numbers and to undertake comprehensive economic impact assessment of policy reforms based on real data.

### ➤ *Prerequisites*

Participants should be familiar with intermediate microeconomics (Master's level). In the run-up to the workshop, participants should get to know the basics of the programming language GAMS which is used for the numerical implementation of equilibrium models as well as data management. A compact do-it-yourself GAMS tutorial will be sent out to participants in advance.

**Participants are required to bring along their own laptop and adapters for 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.

### ➤ *Payment*

The fee for participating in the training workshop is 2,500 Euro and includes lectures, course material and lunches. 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 12, 2019**. 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 the course coordinator Elias Sobotka. A decision on the allocation of scholarships will be made until **July 19, 2019**, in order to allow for an early arrangement of flights, visa etc.

### ➤ **Registration**

Please contact the course coordinator if you have any questions:

*M. Sc. Elias Sobotka  
University of Duisburg-Essen  
Department of Economics  
45117 Essen, Germany  
Telephone: +49 (0)201-183-2845  
Fax: +49 (0)201-183-3974  
email: [rgss\(at\)vwf.uni-due.de](mailto:rgss(at)vwf.uni-due.de)*

The registration deadline is **August 12, 2019**. The maximum number of participants is restricted to 16! **Slots are guaranteed only upon full payment of fees through the course coordinator.** Cancellations will be fully refunded if made prior to **August 12, 2019**. 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. The organizer also reserves the right, in the unlikely case of very limited enrolment, to run the workshop with one instead of two external instructors.

### ➤ **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. Detailed venue information will be provided after reservation.

Some rooms of category C have been earmarked until **early September** under the keyword “*Ruhr Graduate Summer School*” at:

*Bildungshotel im Bfz-Essen e.V.  
Karolingerstraße 93  
45145 Essen, Germany  
T: 0201/3204-243; F: 0201/3204-277  
[bildungshotel@bfz-essen.de](mailto:bildungshotel@bfz-essen.de)*

## ➤ *How to prepare*

No previous knowledge of GE modeling is assumed. However, participants should be familiar with intermediate microeconomics and get somewhat acquainted **beforehand** with GAMS which is the (rather intuitive) programming language used for computer-based model implementation. To be able to follow during the workshop, we suggest for the purpose of preparation the following introductory readings and a short do-it-yourself GAMS tutorial:

- Böhringer, C., Rutherford, T.F., Wiegard, W. (2003): Computable General Equilibrium Analysis: Opening a Black Box, ZEW discussion paper 03-56.
- Rutherford, T.F. (1999): Applied General Equilibrium Modelling with MPSGE as a GAMS Subsystem, *Computational Economics* 14, 1-46.
- Rosenthal R. E.: A GAMS Tutorial.
- J. R. Markusen teaching materials for a course “Simulation Modeling in Microeconomics”, especially chapters 1-4.

Get familiar with GAMS:

- Download the GAMS User's Guide.
- Download the Demonstration Version of GAMS. The GAMS 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 and an introduction to GAMS from Jensen (2006).

Workshop literature:

- Böhringer, C.; Wiegard, W., Starkweather C., Ruocco, A. (2003): Green Tax Reforms and Computational Economics A Do-it-yourself Approach, *Computational Economics* 22 (1), 75-109.
- Böhringer, C.; Löschel, A. (2006): Promoting Renewable Energy in Europe: A Hybrid Computable General Equilibrium Approach. *The Energy Journal*, Special Issue 2, 135-150.
- Böhringer, C.; Hoffmann, T.; de Lara Peñate, C.M. (2006): The Efficiency Costs of Separating Carbon Markets Under the EU Emissions Trading Scheme: A Quantitative Assessment for Germany, *Energy Economics* 28 (1), 44-61.
- Böhringer, C.; Moslener, U.; Koschel, H. (2008): Efficiency Losses from Overlapping Regulation of EU Carbon Emissions. *Journal of Regulatory Economics*, 33 (3), 299-317.
- Böhringer, C.; Rutherford, T.F. (2008): Combining Bottom-up and Top-down. *Energy Economics*, 30 (2), 574-596.
- Böhringer, C.; Rutherford, T.F. (2009): Integrated Assessment of Energy Policies: Decomposing Top-Down and Bottom-Up. *Journal of Economic Dynamics and Control* 33(9), 1648-1661.
- Böhringer, C.; Rosendahl, K.E. (2010): Green Promotes the Dirtiest: On the Interaction between Black and Green Quotas in Energy Markets, *Journal of Regulatory Economics*, 37(3), 316-325.
- Böhringer, C.; Behrens, M.(2015): Interactions of Emission Caps and Renewable Electricity Support Schemes. *Journal of Regulatory Economics*, 48 (1), 74–96.
- Rutherford, T.F. (1995): Extensions of GAMS for complementarity problems arising in applied economics. *Journal of Economic Dynamics and Control* 19, 1299–1324.
- Rutherford, T.F. (1999): Applied General Equilibrium Modeling with MPSGE as a GAMS Subsystem: An Overview of the Modeling Framework and Syntax. *Computational Economics*, 14, 1-46.