



**THE INTERNATIONAL SCHOOL  
OF INPUT-OUTPUT ANALYSIS**

**MODULES**

**22<sup>nd</sup> International Input-Output Conference  
14-18 July 2014, Lisbon, Portugal**

1. Applied General Equilibrium: an Introduction .....	2
2. Environmental Life Cycle Assessment .....	3
3. Material Flow Analysis .....	4
4. Disasters analysis .....	6
5. Managing Uncertainty in Input-Output Analysis .....	7

# 1. Applied General Equilibrium: an Introduction

Lecturers: Prof. M. Alejandro Cardenete (Loyola Andalusia University, Spain) and Ana I. Guerra (University of Granada)

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## Summary

Computable General Equilibrium (CGE) Models have grown to satisfy the ever-expanding demand for assessing the potential impacts of policies in a wide-range of settings. The increasing interest on these analytical instruments stems from their ability to integrate the different parts of the economic system in a comprehensive economy-wide framework. The objectives of this training session are the following: to provide the linkages from Input-Output (IO) Analysis, Social Accounting Matrices (SAM) to CGE Models, to present the economic principals underlying CGE models and, to show participants how to build a CGE with the General Algebraic Modelling System (GAMS) using empirical data. Apart from offering a complete overview of the CGE modelling, this training session should allow the participants to gain a better understanding of economic policy questions that can be approached with these versatile economic instruments.

## Outline

1. Importance of Computable General Equilibrium Modelling for Economic Policy Decisions.
2. From Input Output Analysis to CGE Models: What makes the difference?
3. An Overview of General Equilibrium Theory.
  - 3.1. The Walras Law and the Walrasian Equilibrium.
  - 3.2. Normative Properties of Walrasian Equilibrium: The Relevance of Uniqueness and Existence for Static Comparative Analysis.
4. Building a "small" CGE Model with GAMS. Part I.
  - 4.1. Getting started: Describing our economy.
  - 4.2. Equilibrium Equations.
5. Building a "small" CGE Model with GAMS. Part II.
  - 5.1. Calibrating and Solving the Model.
  - 5.2. "Playing with the Model": Evaluating Tax Policies.

## Remarks

-It could be necessary that participants have a basic level in Input-Output Tables, Social Accounting Matrices and Micro- and Macro-economic foundations. Participants must bring their laptops with them.

-We will provide participants a link where they can download a "Demo" GAMS version.

## References

Applied General Equilibrium. An Introduction, M. A. Cardenete, A. I. Guerra and F. Sancho, Springer, 2012.

## 2. Environmental Life Cycle Assessment

Lecturer: Sangwon Suh

Bren School of Environmental Science and Management

University of California, USA

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**Objective:** this class aims at understanding the basic principles of Life Cycle Assessment (LCA) and how Input-Output Analysis (IOA) and LCA can benefit each other. Main assumptions, computational structure and data sources of LCA will be discussed, and participants will analyze and solve numerical examples through hands-on exercises.

**Background and motivation:** LCA is a tool to evaluate environmental impacts of goods and services. It has been used by manufacturers and researchers to compare alternative design parameters, processes, raw materials and logistics options. Over the last decade, the need to analyze environmental impacts of production and consumption at a national and international-level led to the use of IOA in LCA. Nation-wide LCA studies have been performed in Europe, North America, Japan and China applying input-output tables. In parallel, some LCA researchers recognized the need of addressing data gaps in detailed, process level LCA using environmentally extended input-output tables, which led to the development of hybrid LCA. Other methodological connections between IOA and LCA have also been recognized in the literature. For example, the link between allocation in LCA and supply-use framework in IOA has been discussed; marginal or consequential modeling also has an overlap between the two fields. Today, many LCA practitioners use IOA and vice versa, whereas there still seems to be a disciplinary barrier between them, which motivated the organization of this class.

Course topics:

### 1. Introduction to LCA

- Goal and Scope definition
- Life Cycle Inventory
- Life Cycle Impact Assessment

### 2. Product-by-Process framework

- Computational structure
- Hands on exercise
- Allocation
- Comparison with IOA

### 3. Truncation problem and hybrid LCA

- Data gap in process LCA
- Computational structure of hybrid LCA
- Remaining issues in hybrid LCA
- Hands on exercise
- Iterative hybrid method

### 4. Nation-wide LCA studies

- Motivation
- Key outcomes
- Hands on exercise

### 5. Marginal and/or consequential modeling

- Key issues in marginal/consequential modeling
- Approaches to marginal/consequential modeling
- Hands on exercise

### 3. Material Flow Analysis

Lecturer: Stephan Lutter

Vienna University of Economics and Business, Austria



#### **Motivation:**

History reveals that economic and thus human development have always been closely linked to the control and production of materials. Gathering information on human's material consumption is hence important, as many of today's most pressing environmental problems are directly linked to the extent of our use of materials. The main purpose of economy-wide material flow accounting (EW-MFA) is to provide information on composition and changes of the physical structure of socio-economic systems. MFA represents a useful framework for analysing the relationship between the economic system and the environment and deriving aggregated indicators. Main areas of application of MFA include among others (1) historical analysis, (2) globalisation, trade and environmental distribution, and (3) the integration with data on the structure of our economies (e.g. via input-output tables), in order to analyse the environmental impact of specific economic sectors and identify “hot spots” where targeted action has to start from.

In order to implement effective strategies towards higher resource efficiency, the research group “Sustainable Resource Use” at the Vienna University of Economics and Business measures and analyses human resource use. The group’s work includes the development of methods and indicators of environmental statistics, calculations of resource use at the global, national, sectoral and product level and the compilation of international environmental databases. The group has a long and renowned expertise in EW-MFA and is constantly contributing to methodological improvements of accounting methodologies by means of research projects such as the EU-FP6/7 projects EXIOPOL, CREEA, and DESIRE as well as through participation in research exchange with Eurostat. In this context, in recent years, focus has been set more and more on the improvement of methodological approaches regarding integrating MFA data with input-output data and models respectively. The above mentioned projects are the best examples in this regard.

Before this background, I would like to thank for the kind invitation to present a proposal for a module on Input-Output and Material Flow Analysis for the fourth edition of the International School of Input-Output Analysis (ISIOA) of the International Input-Output Association (IIOA) in Lisbon (Portugal) in July 2014. Please find below a first outline of the proposed module which encompasses the foreseen content of the four specific sessions. The underlying idea is to introduce participants into the general methodological approaches of EW-MFA, and building on this knowledge, to show practical applications and uses of EW-MFA especially in combination with input-output analysis. Thereby, I will use various examples of our works with environmentally extended input-output modelling.

I myself, Stephan Lutter, hold a Master in Environmental Engineering from the University of Life Sciences, Vienna, and a Master of Natural Resources Management and Ecological Engineering from the University of Life Sciences, Vienna, and Lincoln University, New Zealand. Over time I have set my working focus on environmental accounting as well as on international trade and globalisation and resource dependencies. From 2007 to 2013 I worked as researcher and deputy head of the research group “Sustainable Resource Use” at

SERI (Sustainable Europe Research Institute) in Vienna, before moving with the whole group to Vienna University of Economics and Business in October 2013. Furthermore, I am co-developer of the worldwide most comprehensive global MFA database ([www.materialflows.net](http://www.materialflows.net)).

### **Outline**

The module on Input-Output and Material Flow Analysis will be split into four sessions, each focussing on different aspects. The first module will introduce the participants into the methodology of economy-wide material flow analysis (EW-MFA), followed by the second session focussing on the possibilities and methodologies to link EW-MFA with (single-region and multi-regional) input-output modelling. The third session will show practical examples of applying environmentally-extended input-output model results on eco-economic policy making. Finally, session four will give an overview of the status quo in research on EW-MFA and EE-MRIO, introduce ongoing research projects and highlight future research needs.

#### **(1) EW-MFA: methodology, indicators, standards**

This first session introduces the concept of economy-wide material flow analysis (EW-MFA). We start with a short look into the history of EW-MFA and then get a deeper insight in the methodological basis, including definition of main material groups and issues related to boundary setting. Further, the main indicators to be calculated and their informative values will be presented. Main sources for international datasets on EW-MFA will be reviewed. Finally, the main standards for EW-MFA (most importantly, Eurostat and OECD) and ongoing processes will be discussed.

**Objective:** Participants get basic knowledge about the EW-MFA methodology, derived indicators and existing standards as well as sources for material flow data on the international level

#### **(2) MFA and (MR)IO: methodology and examples**

Research on and application of environmentally extended multi-regional input-output models (EE MRIO) has been gaining relevance during the last decade, as this approach allows for a comprehensive analysis of our societies' impacts on the environment. With regard to materials, EW-MFA offers the most appropriate data basis for an application in combination with single-region and multi-regional IO. In this session we will have a look at the methodological basis of integrating different IO models with EW-MFA and give practical examples in terms of specific results.

**Objective:** Participants understand how to link EW-MFA to input-output models and have knowledge about the current state of the art in MFA-(MR)IO

#### **(3) Application of MFA/EE-MRIO in resource efficiency policy making: “you can’t manage what you can’t measure”**

As EE-MRIO methodology and therefore results become more solid also their application in policy making is gaining relevance. In session three we will focus on specific applications of EE-MRIO relevant in the context of resource efficiency policy making (including e.g. industry benchmarking, headline indicators, issues of trade and outsourcing), show examples and get an overview of additional possible fields of policy making where EE-MRIO could contribute.

**Objective:** Participants get an understanding for the fields of policy application of EE-MRIO

#### **(4) Expanding the threshold knowledge of MFA/(MR)IO**

This session will identify necessary next steps on the research agenda towards a more meaningful analysis building on EE-MRIO. Examples of ongoing research (projects) will be given and upcoming policy questions identified, where EE-(MR)IO could contribute. Thereby, we will build on ongoing work by the lecturer in the field of EW-MFA and EE-MRIO.

**Objective:** Participants get a feeling for the possibilities and challenges of EW-MFA and EE-MRIO and get encouraged to identify further applications and research fields

## **4. Disasters analysis**

**Lecturer:** Yasuhide Okuyama

**University of Kitakyushu, Japan**

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**Aim:** This course aims to introduce the foundation and applications of economic modeling of disaster impacts. The course will examine the concepts and theory of disaster analysis, and these principles discussed in the course provide the basis for analyzing and understanding the disaster impact on an economy. The emphasis in the course will be on the use of input-output model and its variants for the disaster impact analysis. If successfully completed the course, the students will be equipped with the knowledge and skill, and the understanding of the limitations and cautions to estimate the economic impact of disasters. This course will be relevant to those who are interested in economic analysis of disaster, preparedness and mitigation policies against disasters, risk assessment, cost-benefit analysis of disaster counter measures, and natural hazards and disasters in general.

### **Session 1: Introduction, Concepts, and Definitions, and Issues**

- Why economic analysis of disasters is needed?
- Concepts and Definitions
- Analytical Framework (what and to what extent should be estimated)
- Issues of Quantitative Assessment of Disaster Impacts

### **Session 2: Input Data and IO Model**

- Input Data for the Model (ECLAC methodology and others)
- IO Model and Applications

### **Session 3: Impact Estimation with IO Variants**

- IO variants (interregional, SIM, IIM, etc.) and the applications

### **Session 4: Long-run Effect and its Analysis with IO Framework**

- Long-run Effects of a Disaster
- Examples and Methodologies

## 5. Managing Uncertainty in Input-Output Analysis

Lecturers: João Rodrigues

Instituto Superior Técnico, Technical University of Lisbon, Portugal

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In this module we will present the theory of uncertainty of IO systems and you will learn simple algorithms to handle missing and partial information during IO data processing and to estimate the uncertainty and of IO multipliers. The module is organized in four lessons (with 1h30m each) which involve the presentation of the theory and its application to a simplified case-study of multi-scale IO integration. Before the course the students will be given access to the relevant literature and extensions but no previous study is required. The students should bring a computer to perform exercises.

**Lesson 1:** Data structure and partial information: In the first lesson we introduce the basic concepts of IO uncertainty (stochastic properties, accounting identities and so forth) and use an invariance principle to build an MRIO in the presence of partial information.

**Lesson 2:** Missing priors and balancing: In the second lesson we use the maximum entropy principle to obtain algorithms that determine missing uncertainty and correlation data and lead to a balanced set of posteriors.

**Lesson 3:** Multiplier uncertainty and bias: In the third lesson we present a numerical algorithm based on Gaussian quadrature and theoretical expressions based on the Isserlis theorem to study the uncertainty and bias of multipliers.

**Lesson 4:** Sensitivity analysis to assumptions: In the fourth lesson we present the allocation formulation of IO systems and show how, by specifying allocation rules, it is possible to gauge the sensitivity of multipliers to technological assumptions.