THE INTERNATIONAL SCHOOL
OF INPUT-OUTPUT ANALYSIS

MODULES
5th Edition of the International School of I-O Analysis
22 June 2015, Mexico, Mexico City

1. World Input-Output Database

Lecturers: Bart Los and Erik Dietzenbacher

"The World Input-Output Database: Contents, Concepts and Applications"
Lecturers: Erik Dietzenbacher and Bart Los (both University of Groningen)

Objective:
The World Input-Output Database (WIOD, released in Spring 2012) has become very popular among input-output researchers. When doing analyses based on WIOD, it is important to have a feeling for the main advantages and disadvantages of the data. This module aims at giving insights into: why the creation of WIOD (and other recent databases providing global input-output tables) was high on the wish list of input-output researchers; what is included in WIOD; how the tables have been compiled from often inconsistent data sources; and how WIOD can be used. After having completed the course, participants will also have initial hands-on experience with WIOD-based computations in Matlab.

Set-up:
The module will be taught in four blocks of 1.5 hours each.
Block 1: An overview of WIOD: Why, what and how?
Block 2: Data construction procedures
Block 3: Environmental applications of WIOD
Block 4: Economic applications of WIOD

Blocks 3 and 4 contain discussions of articles, plus some computations by students

Course material:
- Dietzenbacher, E., B. Los, R. Stehrer, M.P. Timmer and G.J. de Vries (2013) The construction of world input-output tables in the WIOD project, *Economic Systems Research, 25, 71-98.*
- Arto, I. and E. Dietzenbacher (2014) Drivers of the growth in global greenhouse gas emissions, *Environmental Science and Technology, 48, 5388-5394*
- Los, B. (2014), Concise Manual for Matlab/Scilab
- Timmer, M.P., E. Dietzenbacher, B. Los, R. Stehrer and G.J. de Vries (2015) An illustrated user guide to the World Input-Output Database: the case of global automotive production*, forthcoming in Review of International Economics.*
- Timmer, M.P., B. Los, R. Stehrer and G.J. de Vries (2014), Slicing up global value chains, Journal of Economic Perspectiv*es, 28, 99-118.*

Participants are expected to bring their own laptops with Matlab installed (or with access to Matlab at their home institution). If this is impossible, participants can use Scilab. Such students should contact Bart Los (b.los@rug.nl) at least two weeks before the module will be taught, to discuss issues regarding compatibility between their hardware and the Scilab software.

2. Supply and Use Tables and links to Input-Output Tables (consistent with SNA 2008 and new UN Handbook)

Lecturer: Sanjiv Mahajan

Introduction and overview

Over the past 30 years, the role and use of the Input-Output (I-O) framework has developed rapidly within National Statistical Offices (NSOs) and beyond. In particular, several NSOs produce Supply and Use Tables as the natural framework to bring together components of the three approaches to measuring Gross Domestic Product (GDP), and in turn, when balanced, determining GDP both in current prices and in volume terms.

This teaching module arranged by Sanjiv Mahajan (Member of the IIOA Council) helps to provide an overview of Supply and Use Tables (SUTs) and their links to the I-O Tables (IOTs). In addition, this reflects on key changes due to the SNA 2008 affecting I-O analyses and the approaches to be covered in the new UN Handbook.

The modules are being provided with the aim of developing greater understanding for both the producers and users

as well as young scholars and developing more detailed and advanced sessions for the future. This specific module (over four sessions) **aims** to:

☐Describe key features, identities and structure of SUTs.

☐Briefly highlight allocation of economic transactions in the framework (in line with the SNA 2008).

☐Focus on terminology and different types of classifications, for example, industries and products.

☐Provide examples of the main sources of data.

☐Cover key SNA 2008 changes like the capitalisation of R&D and goods sent abroad for processing.

☐Illustrate how GDP is derived from the SUTs using the three different approaches to measuring GDP.

☐Cover the "H-Approach" showing the links between SUTs and IOTs (both in current prices and previous

years' prices) as used in the new UN Handbook.

The above aspects will lead to a practical exercise in each session. The attendees will have simple case studies andwill be requested to populate and balance a simple Supply and Use Table in the third session.

Prerequisites

This training session is limited to around 15 scholars space permitting. Attendees to note:

☐Basic awareness of the national accounting framework would be desirable but not essential.

☐**Please bring along a pen and calculator (laptops not needed).**

3. Visualisation software (taught in Spanish)

Lecturer: Valentin Solis

Objetivo

El objetivo del curso es que los participantes comprendan claramente que la visualización, en el contexto del análisis de insumo producto, es una técnica analítica para ordenar, procesar y obtener conocimientos de la estructura económica de un país o región a través de la representación visual de sus tablas de flujos inter-industriales.

Habilidades adquiridas.

Los estudiantes que participen el curso, desarrollarán habilidades en el manejo de software especializado para procesar las relaciones económicas fundamentales implícitas en distintas tablas de insumo producto y mostrarlas a través de representaciones visuales. Por otra parte, las herramientas de análisis que adquirirán les permitirán trasladar su uso a nuevos contextos.

Primera sesión: Introducción

1) Las tablas de flujos inter-industriales y el modelo de insumo producto. Estadística relacional y estadística de atributos. Conceptos y métodos de observación.

2) Definición de Grafo y definición de una red social. Ejemplos simples de redes sociales. Grafos no orientados, grafos orientados, grafos no valuados, grafos valuados.

3) Elementos fundamentales de un grafo: nodos y enlaces; caminos simples y compuestos, caminos elementales, ciclos, longitud de un camino, distancia geodésica, diámetro, densidad y tamaño de una red; vértices adyacentes, vértices conectados, arcos adyacentes, bucles.

4) Conexidad de un Grafo. Grafos conexos e inconexos. Grafos fuertemente conexos y débilmente conexos.

5) Filtros de la tabla de insumo producto. Matrices de incidencia, matriz de accesibilidad y matriz de distancias.

6) Coeficientes importantes y filtros. Pruebas de conexidad. Familia de matrices de incidencia.

7) El modelo de insumo producto visto como un grafo. Formalización de un modelo de insumo producto.

Segunda Sesión: Software para la visualización de grafos.

1) Principios generales para el trazo de un grafo.

2) Analogías del mundo físico. Tres algoritmos básicos: Eades; Fruchterman y Reingold; Kamada y Kawai.

3) Software para el trazo de grafos. Software libre: Pajek, Ora, Visione, Draw Net y otros. Ejemplos sencillos.

4) Programa Mathematica, versiones recientes y su módulo de Redes Sociales. Introducción de datos, manejo de matrices en el programa, rutinas de filtrado y trazo de grafos. Matriz de insumo producto de México y su visualización. Indicadores de centralidad de esa matriz: Centralidad Nodal, Centralidad por Intermediación y Eigen Centralidad.

5) Ejercicios con 3 matrices de 35 sectores: Japón, Alemania y Brasil.

Tercera sesión. Grafos de grandes dimensiones.

1) Visualización de grafos con miles de nodos. Ejemplos de redes de grandes dimensiones.

2) Matrices multi-regionales de insumo producto: WIOD, EORA, EXIOPOL, JETRO ICIO-OECD.

3) Análisis multi-variante y representación gráfica en espacios de baja dimensión: escalamiento multidimensional.

4) Una nueva visita al programa Pajek. Partición por bloques, extracciones y encogimiento de una red.

5) El programa VOS. Algunas generalizaciones del escalamiento multidimensional. Ejemplos.

6) Interacciones entre los programas Pajek y VOS. Representación de una matriz de insumo producto de México con 270 sectores.

7) Visualización de una matriz multi-regional; el caso de la WIOD (World Input Output Database) con 1400 sectores.

Cuarta Sesión: Tópicos avanzados.

1) Simplificación y visualización de redes. Métodos del análisis multivariante: PCA y MDS.

2) Detección de Comunidades y agregación de los nodos de cada comunidad en un solo nodo.

3) PathFinder y poda de redes. Pathfinder networks.

3) Un método sin perdidas de información en modelos de insumo producto de gran tamaño. Matrices Hermiticas y tablas de flujos inter-industriales. Análisis eigen-espectral en el espacio de números complejos.

4) Programa de cómputo para análisis espectral en el campo de números complejos. Representación visual con mapas térmicos. Ejercicios con una matriz de tamaño intermedio, México en el año 2012 con 270 sectores y el caso de la WIOD en el año 2011 y con 1400 sectores.

Objective.

The course objective is that participants clearly understand that visualization, in the context of input-output analysis, is an analytical technique to sort, process and gain knowledge of the economic structure of a country or region through the visual representation of its inter-industry tables.

Learning Outcomes

Students participating the course will develop skills in the use of specialized software to process the fundamental economic relationships, implicit in various input-output tables and display them through visual representations. Moreover, the acquired tools would enable them to use into new contexts.

Session I: Introduction

1) The table of inter-industry flows and the input-output model. Relational attributes. Concepts and methods of observation.

2) Definition of a Graph; definition of a social network. Examples of social networks. Undirected graphs, directed graphs, graphs not valued and valued graphs.

3) Basic elements of a graph: nodes and links, elemental paths, cycles, length of a path, geodesic distance, diameter, density and size of a network; adjacent vertices, connected vertices adjacent edges, loops.

4) Connectedness of a Graph. Strongly connected and weakly connected graphs.

5) Filters for the input-output table. Incidence matrices, accessibility matrices and distance matrices.

6) Important coefficients and filters. Connectivity tests. A family of incidence matrices.

7) Formalization of an economic structure in graph terms. The input-output model viewed as a graph.

Second Session: Software for displaying graphs.

1) Graph layouts. General principles.

2) Analogies the physical world. Three basic algorithms: Eades; Frutecman and Reinghold; Kamada and Kawai.

3) Software for graph layouts. Free Software: Pajek, Ora, Visione, Draw Net, and others. Simple examples.

4) Mathematica package. Recent versions and Social Networks module. Data entry and management of matrices. Filtering and network visualization. Mexico´s input output matrix and its visualization. Drawing vertices grouped into communities. Centrality indicators: Degree Centrality, Betweenness Centrality and Eigen Centrality.
5) Exercises with 3 matrices of 35 sectors: Japan, Germany and Brazil.

Third session. Large graphs.
1) Graph layouts with thousands of nodes. Examples of large networks.
2) Multi-regional input-output matrices: WIOD, EORA, EXIOPOL, JETRO, ICIO-OECD.
3) Multivariate Statistical Analysis and graphical representation of input output tables in low dimensional spaces: multidimensional scaling.
4) A new visit to Pajek program. Block partition, extraction and shrinkage of a network.
5) VOS program. Some generalizations of Multidimensional Scaling. Examples.
6) Interactions between Pajek and VOS programs. Representation of an input-output matrix of Mexico with 270 sectors.
7) Visualization of a multi-regional matrix: WIOD (World Input Output Database).with 1400 sectors.

Fourth Session. **Advanced Topics.**
1) Simplification and network visualization. Methods of multivariate analysis: MDS and PCA.
2) Detection of Communities and aggregation nodes of each community on a single node.
3) Pathfinder and simplification of networks. Pathfinder networks.
3) A method without loss of information of input-output large models. Hermitic matrices and tables of inter- industrial flows and a complex Eigen spectral method.
4) Complex Eigen spectral program and visualization with thermal maps. Demonstration with an input output table of intermediate size: Mexico´s input output table with 270 sectors in the year 2012. Demonstration with a WIOD table with 1400 sectors in the year 2011.

4.Subnational MRIO

Lecturer: Mike Lahr and João Rodrigues

The How and Why of Subnational Multiregional Input-Output Accounting

Lecturers: Michael Lahr, Rutgers University, USA

João F.D. Rodrigues, Leiden University, The Netherlands

Objectives.

The main objective is to enable participants of the module to gain a basic understanding of strengths and benefits of subnational multiregional input-output (MRIO) tables as well as their weaknesses. The latter inform when such MRIO tables ought not to be used as official national tables are used.

Motivation.

Input-output tables, including social accounting matrices that embed them, are a macroeconomic tool. In using them, we assume the economics embedded within them more or less represent well the entire economy they have been designed to depict. At the same time we know

(1) interindustry linkages (and domestic value chains) of more open economies are smaller,

(2) specialized economies must engage in a proportional greater amount of trade,

(3) economic specialization can induce further economies of scale—so called "agglomeration economies",

(4) wage rates vary across industries

(5) wage rates vary with the marginal productivity of labor within an industry

(6) capital investments can make labor more productive

(7) households comprise larger shares of the final demands of wealthier economies,

Thus as some regional economies within a nation are more specialized than others, they could trade more, could be more productive, could be wealthier, and could display different average consumer expenditure profiles. In essence then, regional economies within a nation are quite *unlikely* to behave similarly, at least macro-economically speaking.

Still, in regional settings, input-output tables remain a valuable macroeconomic tool. In fact, from some perspectives, particularly that of economic impact and related value chain analyses, they have greater use and, moreover, are often the only cost-effective tool available to do the job.

Students should have either Matlab or Octave installed in their laptops.

Matlab download instructions can be found at

http://nl.mathworks.com/products/matlab/, a license is required.

Octave download instructions can be found at

http://www.gnu.org/software/octave/, no license is required.

Content and outline.

During the course of the module, we will cover (1) bases for defining/selecting pertinent subregions, (2) methods use to guesstimate officially nondisclosed regional data and to scale them to a form comparable to that used in national accounts, (3) simple techniques for measuring interregional trade, and (4) the many roles of account balancing techniques in the construction of regional I-O and MRIO accounts and models. We will also examine some analytical measures in interindustry analysis through their equivalents in geographic space.

(1) What is a region? And what sort of region is the "right" region to use?

This is essential topical matter, but we will run through it rather briefly. Both theoretical and practical concepts of the notion of "the region" will be covered. As will be true throughout subtopics of this module, data availability plays a major role.

(2) Data quality issues: Rolling your own

Data are not always available as you might like them. Some statistical agencies report several types of regional employment and payroll data. Some have more sectoral detail than others; some are more statistically representative of desired populations than others; and still others may have features that are quite desirable from other analytical perspectives. How do you choose among them? Worse, due to statistical confidentiality, some data points are often not disclosed. For some isolated geographic units such disclosure problems can become paralyzing to builders of economic models. This sub-lecture presents a set of techniques that can be used to estimate nondisclosed data as a function of available ancillary information.

Fortunately, such regional data are often hierarchical (e.g., data for municipalities are embedded in those of provinces); so data of higher spatial and/or sectoral orders can be used to inform upper bounds for lower-order data and disclosed lower-order data can serve as lower bounds for nondisclosed higher-level data. We will discuss how such data hierarchies can be used to estimate missing data points. We will also at least briefly discuss how similar data sets (as available over time or across different agencies) can be used to fill in such missing data. Practical examples will be demonstrated and participants will take such data- estimating software for a spin.

(3) Estimating Interregional Trade: Cross-hauling and the Elegance of the Gravity Model

A core assumption of most "homemade" MRIOs is that technology is spatially constant. That is, outside of value-added's share of output, all establishments in an industry of a given nation use inputs in the same proportions everywhere. This is assumed true no matter what level of industry aggregation is available in the national I-O table or whether the national table is for Namibia, El Salvador, Tonga, Lichtenstein, or Russia. We will very briefly discuss (and dispense with) the issues surrounding such a strong assumption.

Severe economic leakage (the heavy use of imports and production of exports) can overcome assumptions regarding industry technology. We will demonstrate why this is so. We will follow this up by showing how to estimate interregional trade via the use of estimated intraregional tables and a simple gravity model formulation. We will focus somewhat on the production intra-regional accounts and the varying quality of available interregional trade data…when it is available at all.

Due to a general lack of data for sub areas of nation, regional analysts have often resorted to using location quotient (LQ) and supply/demand pool approaches to estimating trade. But such approaches are known provide heavily biased trade

estimates—heavily under-estimated when it comes to the trade of goods. Moreover with reductions in transportation costs, wholesaling has become the norm as opposed to the exception. All that, product differentiation even in very detailed industries (besides electric utilities) and the need for analysis for political, rather than economic, regions ensures that most commodities are shipped both ways across regional boundaries—such two-way shipping across boundaries is called "cross-hauling." Unfortunately conventional LQ-based trade estimates do not account for cross hauling. We will touch on this material at least briefly and suggest possible alternatives approaches to estimating interregional trade within a nation.

We will demonstrate the above, pulling examples from both a data-rich and a data-poor nation (possibly the U.S. and Egypt). We will also discuss how to link trade estimation to transportation network models—a solid approach for estimating the economic impacts of transportation infrastructure investments. We will also show how to measure such things as interregional spillover and feedback effects.

(4) The Critical Role of Data Raking: Balancing on a Shoe String.

Statistical agencies that produce national accounts bemoan a lack of pertinent data to do their jobs. The situation is even worse for national sub-regions. Indeed, some of us regionalists are as much (if not more) producers of data as we are consumers of official data. We will have already discussed much about aspect of regional table production in (2) above. But even once those data have been incorporated, it may be that the sum of final demand (GDP by expenditures) does not equal the sum of value added (GDP by production or income). These two sets of accounts must be reconciled—the focus of this course session.

At issue, beyond simple reconciliation of the two forms of GDP, is that some added data detail may be available for use in regional accounts. That is many nations have at least some information on regional consumer expenditures; area finances (taxes, charges, and spending) of the various levels of government, and other transboundary income flows (commuting and investment). Such information should be taken into account if possible. We explain why this is the case through a set of examples.

(5) Presenting Impact Results: Core Measures, Aggregation, and Other Model Tweaking

Time-permitting, we will wrap matters up by discussing why we advocate maintaining as much detail as possible when modeling and aggregating only the model results. Indeed, most public audiences do not want to see the gory details of our efforts, nor do they want to know anything at all about accounting conventions. They want to see big numbers, and they want them yesterday! In this session we show basic approaches to enabling results for energy, environmental, fiscal, and occupational analyses.

5.Trade in Value added

Lecturers: Nadim Ahmad and Norihiko.Yamano

The OECD Trade in Value added Database (TiVA)

Course outline
1. Background. TiVA indicators what, why and how?
2. Structure of OECD Inter-country IO (ICIO) – special features: non-resident expenditures, national constraints
3. Introduction of heterogeneity within manufacturing industry (Mexico and China)
4. Collection of data sources
5. Balancing techniques and challenges: National SNA, SUTs and International trade flows
6. Defining TiVA indicators: formulas and numerical examples
7. Other application and extensions: income and Jobs embodied in trade

Note:
Installation of R (http://cran.r-project.org/) and Microsoft office is recommended beforehand in students laptop.
Sample ICIO tables and R codes will be provided at the beginning of course.

Suggested references: http://oe.cd/tiva , www.wiod.org ,
Related international data
repository: http://stats.oecd.org , https://data.un.org/Default.aspx , http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables, http://www.oecd.org/trade/input-outputtables.htm