Maximum Entropy and Input-Output Analysis

Lecturer

Johannes Többen (Norwegian University of Science and Technology)

Introduction

The principles of Maximum Entropy and the closely related Cross Entropy principle are statistical estimation techniques rooted in information theory that have seen numerous practical applications in various scientific fields including Input-Output Analysis.

Objective

This training module provides a brief introduction to the basic theory of Maximum Entropy and Cross Entropy models and shows their usefulness to solving issues when working with Input-Output data. These include the balancing of trade matrices and Input-Output matrices, the disaggregation of sectors and/or regions as well as the estimation hybrid (mixed units) Input-Output Tables by means of small scale exercises to be solved in GAMS.

The students should bring a laptop to the sessions with (at least) the demo version of GAMS installed (www.gams.com/latest).

Organisation and content

Session 1

- Introduction to the principles of Maximum Entropy (ME) and Cross Entropy (CE).
- Balancing Input-Output and Supply-Use Tables: Cross Entropy and RAS.
- Application: A simple matrix balancing problem.

Session 2

- Generalised Maximum Entropy (GME) and Cross Entropy (GCE).
- Dealing with errors and inconsistent data.
- Application: Matrix balancing under conflicting information.

Session 3

- The unconstrained dual and computational efficiency in large-scale problems.
- Harmonising data across mismatching sector classifications.
- Application: Disaggregating Input-Output data.

Session 4

- Harmonising data across multiple units of measurement.
- Application: Constructing hybrid (mixed unit) Input-Output Tables.

References

- Golan, A. (2006) Information and Entropy Econometrics — A Review and Synthesis. Foundations and Trends in Econometrics, Vol. 2. https://www.nowpublishers.com/article/DownloadSummary/ECO-004
- Robinson, S., A. Cattaneo and M. El-Said (2001) Updating and Estimating a Social Accounting Matrix using Cross Entropy Methods. Economic Systems Research, 13.
- Többen, J. (2017): On the simultaneous estimation of physical and monetary commodity flows. Economic Systems Research, 29.

Historical Roots and Theoretical Background of Input-Output Analysis

Lecturer
Heinz D. Kurz and Christian Lager (University of Graz, Austria)

Introduction

As a starting point the contributions of the Classical economists and their view of a multi-sectoral and circular economy where commodities are produced by means of products and original factors of production are explored. Important concepts such as long run position, prices of production, capital and a uniform rate of profits are to be discussed.

Scrutiny reveals that Leontief's predecessors such as François Quesnay, Adam Smith, David Ricardo, Karl Marx, Vladimir K. Dmitriev, Ladislaus von Bortkiewicz and other scholars share common concepts which constitute the core of Classical economic theory.

It is demonstrated that Classical economics differ from the contemporary Neoclassical model in many aspects such as methodology, the notion of equilibrium, the concept of value and distribution, the set of exogenous and endogenous data as well as the underlying crucial assumptions or beliefs. Hence, it seems to be an important issue for scholars working in the field of Input-Output whether Leontief was a Classical or a Neoclassical economist to decide which paradigm provides the adequate background for Input-Output Analysis and to conclude which theoretical model should be utilised for one or the other application.

Finally, the different routes to the theory of production, value and distribution are discussed. Tools and concepts, such as sectoral (dis)integration or period of production, which were developed and utilised in the various contributions of Leontief, von Neumann and Sraffa or some Austrian and Neo-Austrian scholars are discussed and compared and similarities as well as dissimilarities are revealed. Finally, the limitations to the fixed coefficient Input-Output model will be discussed.

Objective

Some if not most studies in the field of Input-Output are usually not embedded or even linked with economic theory. The proposed module aims at (i) exploring the historical roots of Leontief's approach to Input-Output and (ii) providing a sound theoretical background for Input-Output Analyses.

Organisation and content

The four sessions are:

- Session 1: Input-Output analysis ante literam: The contributions of the Classical economists (Heinz D. Kurz).
- Session 2: Switching and re-switching in Leontief´s approach to input-output economics (Heinz D. Kurz).
- Session 3: Classical and Neoclassical Economics: Two paradigms and many differences (Christian Lager).
- Session 4 The Austrians, Leontief, von Neumann and Sraffa: Different routes to the theory of production, value and distribution; Limitations to the (fixed coefficient) input output approach (Christian Lager).

References

- Heinz D. Kurz and Neri Salvadori, Theory of Production, A Long-Period Analysis, Cambridge University Press, 1995.
- Heinz D. Kurz and Christian Lager (eds.), Special Issue: Input-Output Analysis and Classical Economic Theory, Economic Systems Research, 12(2): 2000.
- Olav Bjerkholt and Heinz D. Kurz (eds.), Special Issue: The History of Input-Output Analysis, Leontief's Path and Alternative Tracks, Economic Systems Research, 18(4): 2006.

Economic Performance

Lecturer
Thijs ten Raa (Tilburg University, Netherlands)

Introduction

How do we measure the performance of an economy? An economy is a machine that transforms resources to a standard of living of the consumers. An economy performs better if it achieves a greater standard of living with lesser resources. This course links Input-Output and mainstream economic analyses.

Objective

In this course, we measure what goes into the economy (the resources) and what comes out of it (the standard of living), decompose performance in productivity and efficiency, relate it to index measures, and decompose into industry measures. We learn how the concepts of microeconomic theory can be made concrete using Input-Output accounts.

Organisation and content

The four sessions are:

- Session 1: Introduction, LP that determines the potential output of a production unit, Shadow prices are productivities, Efficiency, Total factor productivity, Multiple outputs and intermediate inputs.
- Session 2: Debreu's coefficient of resource allocation, Consumer preferences, Better set, Input-output consumption vectors yield conservative inefficiency estimates and solve the aggregation problem.
- Session 3: The interrelation between productivity and efficiency measures, Disaggregation by industries, Domar aggregation of industry productivities, Malmquist, Törnqvist and Fisher indices.
- Session 4: Conclusion and exercises.

References

- Lecture notes will be given to course participants.
- Useful preparation is Thijs ten Raa, Microeconomics: Equilibrium and Efficiency, Palgrave Macmillan (2013), Sections 8.3 (The production possibility set), 9.8 (Equilibrium analysis of production economies) and 11.3 (Analyzing dynamic efficiency).

Trade-SCAN: a Trade Supply Chain Analysis tool for computer dummies

Lecturers
Iñaki Arto (Basque Centre for Climate Change - BC3, Spain)
Antonio F. Amores (European Commission's Joint Research Centre)

Introduction

Supply Chain Analysis is a hot topic among researchers, analysts and policymakers. However, the complexity of the underlying quantitative methods often prevents them of using it or exploiting it to its full potential. This module presents a software tool aimed at increasing the accessibility of supply-chain analysis to potential users with minimal skills on quantitative economics and computing.

Objective

The main objective is to introduce participants on the use of the Trade-SCAN software, a new tool with a Graphical User Interface to disentangle the factor content of global value chains.

Organisation and content

This is a practical focused module, therefore, for practical instrumentation, a set of files with the solutions will be provided with all the exercises.

- Session 1: Mathematics underlying the decomposition of the factor content of trade.
- Session 2: Introduction of the Trade-SCAN software tool: General Overview, Pocketbook and Dashboard modules.
- Session 3: Trade-Scan - Ad-hoc queries module.
- Session 4: Application - Hands on session using the adhoc module for examples of their own interest.

Students need pc with GAMS license (demo is not enough) and Excel to be able to use the ad-hoc queries module of Trade-SCAN (only available for Windows). Basic I-O knowledge is indispensable.

References

- Arto, I., Dietzenbacher, E., Rueda-Cantuche, J.M., 2018. Measuring bilateral trade in terms of value added. Paper presented at the 26th International Input-Output Conference, Juiz de Fora (Brazil).
- Arto, I., Rueda-Cantuche, J.M., Cazcarro, I., Amores, A.F., Dietzenbacher, E., Román de Lara, M., Kutlina-Dimitrova, Z., 2018. EU exports to the World: Effects on Employment. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/239212
- Arto, I., Rueda-Cantuche J.M., Cazcarro, I., Amores, A.F. Dietzenbacher, E., Román de Lara, M., Kutlina-Dimitrova, Z., 2018. EU Exports to the World: Effects on income. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/504224

Resources, Technologies, and Consumption: The World Trade Model

Lecturers

Faye Duchin (Rensselaer Polytechnic Institute, United States)
Carlos López-Morales (El Colegio de México, Mexico)

Introduction

The course introduces the World Trade Model (WTM), an Input-Output model of the global economy, based on the economic theory of comparative advantage that reflects the interdependencies among consumption, resource endowments, production technologies, and trade.

The model takes the form of a linear program, minimising the use of factors of production required to satisfy final uses subject to the availability of natural resources. Like any linear program, the WTM consists of a primal model determining production quantities in each region and a dual model determining world prices and region-specific scarcity rents.

Objective

The course is designed with the following objectives:

- To learn about the theory of comparative advantage and its application to an Input-Output model of the global economy.
- To learn about how to design scenarios concerning sustainability that depend on the links among consumption, resources, technologies, and trade as represented in the model.
- To learn about data development necessary for the model, and about how to run it with a computer.

Organisation and content

The introductory session of the course provides an overview. The next module presents the conceptual structure of the model and the strategy behind scenario formulation, followed by an empirical, interregional application about water scarcity in Mexico to illustrate the model's main features. In the next module, students will run scenarios about resource recovery in a global economy to reveal the role of interregional trade. The final module will be a seminar-like session to design scenarios corresponding to the students' interests. These ideas form the basis of the assignment.

Introduction

- Presentation of lecturers
- Computational requirements
- Overview of the course

The World Trade Model

- Why do we need a model of inter-regional exchange?
- Basis in the theory of comparative advantage
- The MRIO model and MRIO database
- Algebra of the World Trade Model (WTM)
- Algebra of the WTM's one-region counterpart, the Rectangular Choice-of-Technology (RCOT) Model

Implementation: Water for agriculture

- Defining policy options for addressing water scarcity
- Empirical analysis: scenarios, data, and implementation
- Discuss question addressed, results, and interpretation
- Analyze an alternative scenario

Practice: a global application

- Question to be addressed
- Resource recovery: different implications for different regions
- Application using illustrative data
- Alternative scenarios

Practice: design a new application

- Discussion of topics
- Brainstorming on formulation and representation of scenarios
- Developing a database
- Formulation of assignment around the application

References

- Duchin, F. (2005). A world trade model based on comparative advantage with *m* regions, *n* goods, and *k* factors. *Economic Systems Research*, *17*(2), 141-162.
- Duchin, F., & Levine, S. H. (2011). Sectors may use multiple technologies simultaneously: The rectangular choice-of-technology model with binding factor constraints. *Economic Systems Research*, *23*(3), 281-302.
- Duchin, F., & Levine, S. H. (2012). The rectangular sector-by-technology model: not every economy produces every product and some products may rely on several technologies simultaneously. *Journal of Economic Structures*, *1*(1), 3.
- Duchin, F., & Levine, S. H. (2019). The recovery of products and materials for reuse: The global context of resource management, *Resources, Conservation, and Recycling*. In press.
- Duchin, F., & López-Morales, C. (2012). Do water-rich regions have a comparative advantage in food production? Improving the representation of water for agriculture in economic models. *Economic Systems Research*, *24*(4), 371-389.
- López-Morales, C., & Duchin, F. (2011). Policies and technologies for a sustainable use of water in Mexico: A scenario analysis. *Economic Systems Research*, *23*(4), 387-407.
- López-Morales, C. A., & Duchin, F. (2015). Economic implications of policy restrictions on water withdrawals from surface and underground sources. *Economic Systems Research*, *27*(2), 154-171.