AAE 526: Quantitative Methods in Agricultural and Applied Economics

University of Wisconsin Madison

MWF –1:20-2:10, Agricultural Hall 10
Fall Semester, 2021

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Overview

What modeling frameworks can be used to evaluate the economic consequences of Brexit? How does road infrastructure affect congestion and urban unemployment? What about methods for evaluating the impact of parking fees on urban traffic congestion? How do renewable portfolio standards affect regional electricity prices? Economic equilibrium models provide one method of producing *ex-ante* assessment of policy impacts in a wide range of policy issues.

The starting point for this course will be nonlinear programming, a modeling format commonly employed in economic and managerial decision making. We will subsequently introduce nonlinear complementarity models, a format which is well suited for models based on the building blocks of microeconomics (price theory and game theory).

This course provides an introduction to applied general equilibrium and other applied models of economic choice commonly formulated for economic policy analysis. The course will more generally cover applications of nonlinear optimization and complementarity methods in economics, with a problem-solving perspective emphasizing the formulation and application of models to economic issues.

This semester we focus on (i) partial and general equilibrium models commonly applied for trade policy analysis, (ii) linear and nonlinear programming methods for estimation and matrix balancing, (iii) bottom-up models for transportation and electricity networks, (iv) methods for top-down / bottom-up assessment of transportation and electricity policy impacts from an economy-wide perspective.

Learning Objectives

This is a three credit course appropriate for undergraduate and graduate students interested in learning about economic policy analysis, applied nonlinear programming, and the use of numerical methods in economic policy analysis. This semester will focus on applications in traffic and electricity networks in addition to mainstream economy-wide general equilibrium applications. The course is open to students who have had been introduced to textbook models of economic choice, linear algebra and calculus. Familiarity with linear programming is recommended but not required.

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Economics students will be introduced to a bit of the science and art of numerical modeling. Industrial engineering and computer science will be introduce to some of the key ideas in the economic theory of choice and their application to practical issues.

The course incorporates skills related to both numeracy and literacy. We will learn about how to locate and interpret economic datasets. We learn to use a modeling language, methods for graphical representation and elementary spreadsheet and database skills for understanding data. We develop an appreciation for the role of models and evidence in the rhetoric of economic policy.

Learning outcomes for the class are as follows:

i. Develop an understanding of the use of calibrated economic models to study economic policy and the underlying applied price theory.

ii. Gain expertise in the formulation of numerical economic equilibrium models with application to trade, public finance, climate and energy policy applications.

iii. Learn about data sources for sectoral and economy-wide policy applications of calibrated economic equilibrium models.

iv. Learn how to use GAMS, Excel and other visualization tools to analyze and interpret large, multi-dimensional datasets and models.

v. Demonstrate competence in writing about economic issues on the basis of evidence-based analysis of economic policy proposals.

vi. Learn equivalent formulations of partial and general economic equilibrium models in primal, dual and complementarity formats. (Grad only).

Instructional Mode: Face-to-face

Assignments and Assessment

- Five homework assignments (20% total) due on September 23, October 7, November 4 and November 18.
- A modeling application (40% total due December 3)
- One mid-term exam (15%, held in class on Wednesday, October 20)
- A final exam (25%, Friday, December 17, 5:05pm, location TBA).

Homework assignments must be done individually, but the modeling assignment can be completed in groups of two. The assignments will preparation of a short paper and a deck of slides outlining your approach to the problem, model formulation, data and results.

Texts and Teaching Resources

Class notes, assignments, readings, and other resources will be posted to the class site Canvas page on Learn@UW. A few readings will have direct web links from the syllabus. My goal is to place the PDF lecture notes on line by the evening before lecture to encourage participation by providing a clear summary of what material the class session will cover. Access to the site requires registration for the class and a valid UW NetID.

The course will use the GAMS modeling language runs on both Windows and Mac computers. The course license for GAMS is posted on the course web page.This license will work with all platforms supported by GAMS and will expire at the end of 2018.

You may download the latest GAMS distribution from: `http://www.gams.com/download/`. Release notes and detailed installation instructions can be found at the top of that page. GAMS system documentation is provided electronically with the software and is also available at: `http://www.gams.com/latest/docs`. There are also several videos on YouTube introducing GAMS (e.g., `https://www.youtube.com/watch?v=p1D86dpyFfY&t=586s`).

Topics

There are three parts to the course. The initial lectures will focus on partial equilibrium models and econometric applications. This section of the course will introduce GAMS/LP, GAMS/QCP, GAMS/NLP, and GAMS/MCP modeling formats (linear, quadratic and nonlinear optimization and mixed complementarity). The link between optimizaiton and complementarity programming is applied Lagrangian duality. Subsequent set of lectures will introduce general equilibrium analysis and GAMS/MPSGE, and the final set of lectures will deal with integrated top-down / bottom-up models.

Lectures and homework introduce the GAMS modeling language.

Weekly topics are as follows:

Market Equilibrium and Integrability

Linear, quadratic and nonlinear Programming

Lagrangian duality: nonlinear complementarity

Applications: disruptive trade policy, electricity network pricing, Wardropian traffic equilibria.

Conjugate duality: cost and expenditure functions:

General Equilibrium

Applications: trade policy, environmental policy, transportation network investment

Estimation, Calibration and Estibration

Trade policy analysis with general equilibrium models.

Textbooks

Background material for the course is covered in two textbooks. Simon and Blume provide an introduction to the mathematics of constrained optimization. Varian provides an intuitive introduction to the economic models and their application.

- Mathematics for Economists by Carl P. Simon and Lawrence E. Blume Norton, W. W. & Company, Inc.
- Intermediate Microeconomics, A Modern Approach Hal R. Varian (Author, University of California, Berkeley)

The remainder of readings for the class will be provided on the course web page.

Contact Information: Thomas F. Rutherford

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- Office hours:
  - Wednesday (3:00-4:00 pm): Taylor Hall 323
  - Thursday (9:00-10:00 am): by Zoom