ECON 400 Computable General Equilibrium

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Course meetings: Tyler Hall Rm 217, MWF 1000 – 1050
Office hours: Friday 1100 – 1150, and MW by appointment

1. Course overview

Before a proposal becomes official, policy makers often want to know how it would affect various parts of the economy. For example, what winners and losers would a carbon tax produce? How would nonfarm workers be affected by a tariff on wheat or another agricultural commodity?

To answer those questions, economists often turn to Computable General Equilibrium, or CGE, modeling. This class of economic models assesses how the entire economy, including industries and households, is affected by policy changes in areas such as taxation, migration and trade policy.

Not surprisingly, CGE modeling has influenced many debates in international development, such as trade policy, migration, climate change, carbon trading, food prices and pro-poor economic growth policies.

A Computable General Equilibrium **(CGE)** model is one of the most rigorous, cutting-edge quantitative methods to evaluate the impact of economic and policy shocks -particularly policy reforms- in the economy as a whole. Because of its nature, this tool is significantly useful for policy design.

CGE modeling reproduces -in the most possible realistic manner- the structure of the whole economy and therefore the nature of all existing economic transactions among diverse economic agents (productive sectors, households, and the government, among others).

Thus, because of its nature, CGE analysis performs well when evaluating, among others:

1. Fiscal policy
2. Trade policy
3. Environmental and energy policy

This course has two overarching objectives:

1. Provide you with a tool for optimization and policy evaluation;
2. Provide you with an understanding of how economic models can be implemented numerically and how different individual characteristics will affect behavioral responses and policy effects.

2. Course Materials

2.1. Textbook

No text book is required for the couse. Reading and lecture notes will be available on blackboard.

Should you be interested in some books to check out, the following are highly recommended:

1. Textbook of Computable General Equilibrium Modelling by Nobuhiro Hosoe, Kenji Gasawa and Hideo Hashimoto.
   https://www.palgrave.com/us/book/9780230248144
2. Introduction to Computable General Equilibrium Models by Mary E. Burfisher
   https://www.cambridge.org/us/academic/subjects/economics/econometrics-statistics-and-mathematical-economics/introduction-computable-general-equilibrium-models-2nd-edition?format=PB&isbn=9781107584686
3. General Equilibrium Theory: An Introduction by Ross M. Starr
   https://www.cambridge.org/us/academic/subjects/economics/microeconomics/general-equilibrium-theory-introduction-2nd-edition?format=PB

2.2. Software

We will use the software **GAMS**: **G**eneral **A**lgebraic **M**odeling **S**ystem.

We will introduce the software in the class room and I will provide you with guided instruction and exercises to help you to learn to use GAMS to solve economic optimization problems.

A free student license is available for the duration of the course.

The General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical programming problems. The term **mathematical programming** has come to be used to describe the minimization or maximization of an objective function of many variables, subject to constraints on the variables. GAMS is tailored for complex, large-scale modeling applications, and allows you to build large maintainable models that can be adapted quickly to new situations.

3. Assignments and grading

3.1. Grading

I will calculate course grades based on the following items. You need to complete all items to receive course credit. Students not completing all items will receive an Incomplete.

Percent	Item
40	Homework assignments
60	Final paper

In general, I will base grades on the following percentage scale with partial-percents typically rounded to the nearest full percent: A=93-100; A-=90-92; B+=88-89; B=83-87; B-=80-82; C+=78-79; C=73-77; C-=70-72; D+=68-69; D=63-67; D-=60-62; F<60.

In a class such as this, any grade below a "B" on any assignment, exam, or paper suggests that a student is having trouble grasping basic course ideas, which are essential building blocks for future courses and the work world. Please talk with me if you find yourself having difficulty.

Finally, because errors sometimes creep into grade calculations (and on rare occasions assignments are misplaced after they have been handed in) please keep a copy of all work submitted for this course until final grades have been processed.

3.2. Homework assignments

These assignments will focus on real life policy questions. It is crucial that you complete these assignments on time. Grading will stress two things: (1) the degree to which you have made a strong effort to complete all parts of each assignment; and (2) the extent to which your work, especially the computing component and the writing component, is polished and professionally done.

The homework assignments will provide you with a way to practice the computational skills need for applied policy analysis using computable general equilibrium models.

You will have five assignments that will involve a detailed write up for a simple model, analysis or component of the model development.

1. Introduction to GAMS and mathematical programming
2. Optimization in Economics - Consumer Theory
3. Household Optimization Behavior - Nested Decision Making Structures
4. The Data of General Equilibrium - The Social Accounting Matrix
5. Applied Policy Evaluation

3.3. Final Paper

The course's capstone paper will provide you an opportunity to use your quantitative skills in an area that you choose. I will make some data sets available but you may also use data from another source. More details about the paper will be forthcoming.

4. COURSE PHILOSOPHY

This course is designed for you to take initiative in synthesis and critical analysis, to solve problems in an applied and/or academic setting, to create original material or original scholarship, and to communicate effectively with a diversity of audiences.

Assignments in the course specifically encourage synthesis and critical analysis

The applied methods used in this course in the 5 homework assignments and in the independent, capstone project developed by the student encourage a critical analysis of economic theory by requiring the student to examine the behavioral implications of economic theory.

Assignments involve solving problems in an applied and academic setting, and creating original material or original scholarship

The applied computational methods used in this course have very natural extensions in a number of different ways. In academic journals, the methods and approaches to economic analysis that we will cover in this class have lead to a wealth of research that has examined the relationship between energy and economic performance in different cities and states in the United States and in different countries and regions around the world. In addition, these studies can and have focused on understanding the relationship between trade policy and economic performance in specific industries, policy affects on income inequality and looking to spillovers between regions and between different industries resulting from trade and environmental policies.

These methods are introduced and studied in the context of 5 homework assignments and culminate in the development of independent student research based on publicly available data.

Communicating effectively to disparate audiences

Students will have to learn to communicate technical information to a non-technical audience. This will require effectively communicating information in a way that is technically complete but accessible to the general public.

The capstone project for the course will require the students to develop an academic research paper that is suitable for submission to a peer-reviewed journal, an op-ed piece that summarizes their work and a blog with five entries highlighting progress on the research. Students will also present their methods and analysis and provide constructive feedback in the class room setting to other students on the independent research projects they develop.

5. Course Topics

We will adjust this schedule as needed. Any changes to assignment due dates will provide you with more time, not less time, to complete the work. You'll notice that the reading assignments repeat for some days. That is intentional because re-reading certain pages in a new context will help to deepen your understanding of prior concepts while establishing new ones.

The first five weeks of the course is designed to help you to develop the skills needed to develop independent research in applied policy evaluation. The next five weeks is designed to introduce subject specific detail and help you in synthesizing and applying economic analysis to an issue of your choosing. The final portion of the course is designed to provide you with support in the development and completion of your independent work.

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1. **Introduction and Course Overview**
2. **Introduction to GAMS and to Mathematical Programming**
3. **Optimization in Economics: Microeconomic Foundations**
   - 3.1. Consumer Theory
     - 3.1.1. Utility and Utility Functions
     - 3.1.2. Utility Maximization
     - 3.1.3. Responses to Changes in the Economic Environment
     - 3.1.4. Multi-level decision making structure
     - 3.1.5. Labor-Leisure Choice
     - 3.1.6. Cost Minimization
   - 3.2. Producer Theory
     - 3.2.1. Production Functions
     - 3.2.2. Profit Maximization
     - 3.2.3. Cost Minimization
4. **Closed Economy General Equilibrium**
   - 4.1. An Elementary General Equilibrium Model
   - 4.2. Model Data, Calibration and Macroeconomic Closures: The Social Accounting Matrix
   - 4.3. A Simple 2x2x2 General Equilibrium Model
   - 4.4. General Equilibrium: Taxation and Fiscal Policy
5. **Open Economy General Equilibrium**
   - 5.1. Armington Trade Model
   - 5.2. Multi-region models

	Date	Topics	Assignments	Note
Week 1	Wednesday, January 22, 2020	Introduction, Course Overview, Tour of the Blackboard Site		First Day of Class
	Friday, January 24, 2020	Introduction to GAMS; Optimization and General Equilibrium		
	Monday, January 27, 2020	Introduction to Linear Programming		
Week 2	Wednesday, January 29, 2020	Linear Programming - Applications I		
	Friday, January 31, 2020	Linear Programming - Applications II		
	Monday, February 3, 2020	Consumer Theory - Utility and Utility Functions	A1 - Linear Progamming and GAMS	
Week 3	Wednesday, February 5, 2020	Utility Maximization		
	Friday, February 7, 2020	Model Calibration - reading data from excel		
	Monday, February 10, 2020	Duality		
Week 4	Wednesday, February 12, 2020	Welfare Analysis		
	Friday, February 14, 2020	Generalization to multiple households		
	Monday, February 17, 2020	Sensitivity to Model Parameterization	A2 - Utility Maximization and Welfare Analysis	
Week 5	Wednesday, February 19, 2020	Nested Model Specification		
	Friday, February 21, 2020	Multi-level decision making structure		
	Monday, February 24, 2020	Labor-leisure choice model		
Week 6	Wednesday, February 26, 2020	Labor-leisure and consumption choices		
	Friday, February 28, 2020			
	Monday, March 2, 2020	Producer Theory - Profit Maximization	A3 - Nested Decision Making Structure	
Week 7	Wednesday, March 4, 2020	Producer Theory - Cost Minimization		
	Friday, March 6, 2020	Producer Theory - Intermediate Inputs		
	Monday, March 9, 2020			Spring Break
Week 8	Wednesday, March 11, 2020			Spring Break
	Friday, March 13, 2020			Spring Break
	Monday, March 16, 2020	General Equilibrium Theory		
Week 9	Wednesday, March 18, 2020	Simple 2x2x2 CGE Model		
	Friday, March 20, 2020	Introducing Taxes and Transfers to the General Equilibrium Model		
	Monday, March 23, 2020	Social Accounting Matrix - Data Collection and Organization	A4 - Closed Economy General Equilibrium	
Week 10	Wednesday, March 25, 2020	Social Accounting Matrix - Data Structure and Intermediate Inputs		
	Friday, March 27, 2020	Social Accounting Matrix - Construction		
	Monday, March 30, 2020	Armington Trade Specification for Imports/Exports		
Week 11	Wednesday, April 1, 2020	The World Bank Trade Model		
	Friday, April 3, 2020	Policy Analysis with General Equilibrium Models		
	Monday, April 6, 2020	Sensitivity to Model Parameterization	A5 - Open Economy General Equilibrium	
Week 12	Wednesday, April 8, 2020	The International Food Policy Research Institute Model		
	Friday, April 10, 2020			Passover
	Monday, April 13, 2020	Greenhouse gas emissions in general equilibrium		
Week 13	Wednesday, April 15, 2020			Passover
	Friday, April 17, 2020	Carbon taxation		
	Monday, April 20, 2020	Distributional implications of environmental taxes		
Week 14	Wednesday, April 22, 2020	Environmental fiscal reform		
	Friday, April 24, 2020	General fiscal reforms		
	Monday, April 27, 2020	Topics and Applications in General Equilibrium	Data for Paper Due	
Week 15	Wednesday, April 29, 2020	Topics and Applications in General Equilibrium		
	Friday, May 1, 2020	Topics and Applications in General Equilibrium		LDOC
	Wednesday, May 6, 2020	**Exam Block**	**Final Paper Due at 5pm**	