Instructors:
Tom Hertel, Krannert 647, Phone: 765-494-4199, Email: hertel@purdue.edu
Zeynep Akgul, Krannert 568, Email: zakgul@purdue.edu

Web Support:
Jeremy Douglas, Email: dougla32@purdue.edu

Course time:
Lectures and lab assignments are offered over the web. Lab assignments are due on Thursday 5:00 pm. Weekly class discussions take place on Monday from 4:30 – 5:30pm. As the semester progresses, we may occasionally use the Wednesday slot as need arises. Special sessions will be arranged during the final week of classes to permit presentation of student projects.

Office hours:
Wednesday, 3:00 – 4:00 pm, as well as other times by appointment (use email to make appointments). Questions and discussions on the web board are strongly encouraged.

Intended Audience:
PhD students, and MS students with strong a foundation in micro-economics, having an interest in the quantitative analysis of economy-wide issues relating to public policy, marketing and international trade, economic development, resources, technology and the environment.

Prerequisites:
Graduate level microeconomics (ECON 511 or ECON 607 or equivalent).

Readings:
All readings will be available on-line, through the password-protected course website.

Software:
Horridge, M., RunGTAP, Center for Global Trade Analysis, Purdue University, 2009.
Grading:
Weekly Homework (50% of grade) – These generally take 2-3 hours to complete and they are submitted electronically on a weekly basis. They comprise the core of the coursework.

Midterm Exam (25% of grade). The purpose of this exam is just to ensure that you have absorbed the key lessons of the weekly assignments during the first seven weeks. We will build on this core material in the second half of the course.

Individual presentation and write-up of special project (25% of grade). This is the ‘main event’. You will choose a topic of interest to you, replicate and extend an existing study, and present your findings to the class. For a list of potential studies available for replication, please refer to the Potential Applications List.

Communication:
The primary out-of-class method of communication for this course will be the class web page and via email to your @purdue.edu account. As a student it is your responsibility to check the class web page and your @PURDUE.EDU EMAIL on a frequent basis at least once every 24 hours.

Emergencies:
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. I will post such changes on the class web page and will send an email to your @purdue.edu account. YOU ARE EXPECTED TO READ YOUR @PURDUE.EDU EMAIL ON A FREQUENT BASIS.

Students with Disabilities:
If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the first three weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. Please note that university policy requires all students with disabilities to be registered with the Office of the Dean of Students before classroom accommodations can be provided. The information is provided at http://www.purdue.edu/drc/

Academic Integrity:
University policy on academic misconduct is clear - academic dishonesty in any form is strictly prohibited. Academic misconduct includes citing someone else’s work as your own, using “cheat sheets” or sharing your answer with someone else. Anyone found to be cheating or help someone else cheat will be referred to the Dean of Students for disciplinary action which may include dismissal from the University. A guide to academic integrity is provided by the Dean of Students office: http://www.purdue.edu/odos/aboutodos/academicintegrity.php. As a student you should be familiar with this material.
**Course Description:**
This course has two objectives. First, and foremost, the course seeks to *provide students with a conceptual framework for looking at issues from an economy-wide perspective*. It is hoped that this will remain with participants *regardless of whether they choose to conduct their own applied general equilibrium (AGE) analyses in the future*. This is accomplished via a set of lectures, homework assignments, and structured computer simulation exercises. These are designed to provide insights into the basic mechanisms and key parameters that determine inter-sectoral linkages in the economy. They are also structured in a way that emphasizes connections to the literature in production, consumption, marketing, trade, resources, welfare and environmental economics. As such, it often helps students to conceptualize the connections between some of their other, more specialized, coursework.

The other objective of this course is to *expose participants to an operational framework (including theory, software and data) for conducting global AGE analysis*, which they can draw upon in future research efforts. They will exercise this framework in the context of a class project to be written up and presented to the class at the end of the semester. This project will involve replication of an existing applied general equilibrium application, followed by an agreed-upon, extension of the published work.

The computer assignments and the course project will all be implemented in the context of the RunGTAP software interface (Horridge, 2009) to GEMPACK. This is a Windows environment for conducting applied general equilibrium analysis with the Global Trade Analysis Project (GTAP) model, designed to allow users to focus on economics with the programming details being largely taken care of behind the scenes. The use of this tool has largely eliminated the time required to get participants “up to speed” on the software front. RunGTAP runs GEMPACK programs “behind the scenes”. GEMPACK is an algebraic modeling language (think GAMS) that permits the user to write out the model in a transparent fashion. It is specifically designed for application to large-scale applied general equilibrium models in a policy-oriented environment. Students will become expert users of these tools, but the design of the course is such that they will not need to become expert programmers in GEMPACK.

The GTAP Data Base we will use is amenable to a wide range of applications. It is currently in use by more than 12,000 researchers on five continents. Many of the leading national and international policy-oriented agencies are also using it, including: World Bank, the WTO, the UN Conference on Trade and Development, the European Commission, the US International Trade Commission, and US Departments of Agriculture, Commerce, Energy and Environmental Protection. Current GTAP applications span a wide range of areas, including: trade policy reform, regional economic integration, resource and environmental economics, impacts of technological progress, climate change impacts and mitigation, and international migration. There is a searchable database of GTAP applications on the web at: [https://www.gtap.agecon.purdue.edu/resources/res_list.asp?SearchField=Type&SearchValue=GTAP+Application](https://www.gtap.agecon.purdue.edu/resources/res_list.asp?SearchField=Type&SearchValue=GTAP+Application)
Course Requirements
The central tool for learning in this course will be weekly homework assignments designed to reinforce the material covered in the lectures. In the second half of the semester, there will be a few additional assignments, but these will diminish in frequency as students become more engaged in their class projects. These projects will involve the replication of an existing, published study, thereupon extending it in some meaningful way. This final presentation and write-up of this work will be in lieu of a final exam. Grades will be based on homework assignments (50%), midterm exam (25%), individual presentation and write-up of special project (25%).

Course Overview

Part I: Closed and Open Economy Analyses: weeks 1-8

- Week 1: Getting Started
- Week 2: Overview of the Closed Economy Model
- Week 3: Producer Behavior and Supply Response
- Week 4: Household Behavior and Demand Response
- Week 5: Welfare Analysis in a Second-best Setting and in-class Midterm
- Week 6: Introduction to the Multi-region model
- Week 7: Global Sectors, Macroeconomic Closure, and Welfare Decomposition
- Week 8: Fall Break and take-home Exam

Part II: Firm Heterogeneity in General Equilibrium: weeks 9-12

- Week 9: The Melitz Model
- Week 10: Alternative Trade Specifications: Armington, Krugman, and Melitz Models
- Week 11: GTAP-HET 1: Firm Heterogeneity in GTAP
- Week 12: GTAP-HET 2: Application to Regional Trade Agreements

Part III: Special Topics: weeks 13-14

- Week 13: Estimating Confidence Intervals using Systematic Sensitivity Analysis
- Week 14: Climate Impacts and Mitigation Analysis

Part IV: Synthesis and Presentations: weeks 15-16

- Week 15: Putting AGE analysis in Perspective: Wrapping things up
- Week 16: Student Presentations

COURSE SYLLABUS

In the course outline that follows each week’s activities may involve seven different types of tools for learning. They are listed in the order in which we recommend they be done.

Lectures: These are both voice-over PowerPoint lectures, as well as lecture notes intended to be carefully read and digested. They are designed to introduce the topics of the week.
**Illustrative simulation:** This offers an opportunity to get your hands “dirty” with a simulation, before all of the material is covered. This can be a useful motivating factor for delving more deeply into the material.

**Required Readings:** Must be read.

**Supplementary Readings:** These are optional.

**Homework:** Homework assignments are due Thursday by 5pm. This gives us the weekend to correct them so that we can discuss any weaknesses/challenge areas the following Monday. Check the course calendar on the website for updates in case assignment due dates are changed.

**Weekly Discussion:** Each week there will be a session at which students can discuss the assignments, lectures and readings, as well as raising other issues. Ongoing discussion will be facilitated via the website bulletin board.

**Special Project:** During the second half of the semester, there will be weekly tasks associated with participants’ special projects, culminating in presentation of their own extension of an existing study.

**Part I: Closed Economy Analysis**

**Week 1. Getting Started**

**Lectures:**
- Lecture 1: Introduction to AGE Analysis: Why General Equilibrium?
- Lecture 2: Motivation for Starting with a One-Region Model

**Illustrative Simulation:**
- Simulation 1: Introduction to RunGTAP for the One Region Model: OneGTAP Tutorial

**Required Readings:**

**Supplementary Readings:**

**Homework:**
- Assignment 1: Viewing of Database and Numeraire Simulation.

**Week 2. Overview of the Closed Economy Model**

**Lectures:**
- Lecture 1: Overview of the Closed Economy, GTAP Framework
- Lecture 2: Accounting Relationships in the One Region Model
- Lecture 3: Price Linkage Relationships
- Lecture 4: Detailed Listing and Derivation of Accounting Equations
- Lecture 5: Tax/subsidy Conventions
Lecture 6: Model equations
Lecture 7: Detailed Listing and Derivation of Price Linkages

Illustrative Simulation:
Simulation 1: Output Tax Shock: Viewing OneGTAP Output

Required Readings:
• Brockmeier, M. “A Graphical Exposition of the GTAP Model”, sections 1 - 3, GTAP Technical Paper No.8, Center for Global Trade Analysis, Purdue University. This can be downloaded from: http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

Supplementary Readings:
Participants should read one of the following surveys of applied general equilibrium analysis to get a feel for how these models have been used in the past:


Homework
Assignment 2: Walras Law

Week 3. Producer Behavior and Supply Response

Lectures:
Lecture 1: Introduction to Producer Behavior
Lecture 2: General and Particular Restrictions on a Production Function
Lecture 3: Notes on the Restrictions on the Production Function
Lecture 3: The Nested CES Production Function: Theory and a Specific Example
Lecture 5: Notes on the CES Functional Form
Lecture 6: A Specific Production Function
Lecture 7: Supply Response in the one region model
Lecture 8: Notes on Supply Response

Illustrative Simulation:
Simulation 1: Conditional (Output Constant) Producer Response to a Change in Input Price
Simulation 2: Supply Response to a Change in Producer Prices

Required Readings:
• Hertel, Thomas W. 2011. "The Global Supply and Demand for Agricultural Land in 2050: A Perfect Storm in the Making?," American Journal of Agricultural Economics. Focus on the technical appendix and interpretation of equation (1) in the text. The appendix may be found here: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=3428

Supplementary Readings:


• Gohin, A. and T. Hertel. 2003. "A Note on the CES Functional Form and Its Use in the GTAP Model" GTAP Research Memorandum No. 02, Center for Global Trade Analysis, Purdue University, USA.

Homework
Assignment 3: Producer Behavior – Conditional Elasticities of Demand

Week 4. Household Behavior and Demand Response

Lectures:
Lecture 1: Overview of Final Demand
Lecture 2: General and Particular Restrictions on Consumer Demand
Lecture 3: Treatment of Government and Savings Demands
Lecture 4: CDE Expenditure Function
Lecture 5: Final Demand in the Presence of Non-homothetic Separability
Lecture 6: Market Demand
Lecture 7: Equilibrium Demand Elasticities & Dalton’s Law

Illustrative Simulation:
Simulation 1: Household Response to a Price Change.
Simulation 2: Introduction to AnalyseGE Software.
Simulation 3: Market Demand Response to a Price Change

Supplementary Lectures:
Lecture 8: Links between AGE Analysis and input-output/social Accounting Matrix based Analysis
Lecture 9: Partial vs. General Equilibrium Closures

Required Readings:

• Hertel, Thomas W. 2001. "Notes on Final Demand in the Presence of Non-homothetic, Weak Separability", Center for Global Trade Analysis, Purdue University (PDF from course website Module 4).

Supplementary Readings:


• McDougall, R.M. “A New Regional Household Demand System for GTAP,” GTAP Working Paper no. 14, Center for Global Trade Analysis, Purdue University. This can be downloaded from: http://www.gtap.agecon.purdue.edu/resources/working_papers.asp

**Homework**
Assignment 4: Analysis of Consumer Behavior

**Week 5: Welfare Analysis in a Second-best Setting and in-class Midterm**

**Lectures:**
- Lecture 1: Equivalent Variation as a Measure of Welfare Change
- Lecture 2: Welfare Decomposition

**Illustrative Simulation:**
- Simulation 1: Welfare Change due to an Output Tax

**Required Readings:**
- Huff and Hertel, 1996 “Decomposing Welfare Changes in the GTAP Model”, GTAP Technical Paper #5, part 1, Center for Global Trade Analysis, Purdue University. This can be downloaded from: http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

**Supplementary Readings:**

**Homework**
Assignment 5: Welfare Effects of a Manufactures Subsidy

**Week 6: Introduction to the Multi-Region model**

**Lectures:**
- Lecture 1: Overview
- Lecture 2: Accounting Relationships
- Lecture 3: Price Linkages
- Lecture 4: Armington Structure
- Lecture 5: Summary of Model Equations
Supplementary Lectures:
Lecture 6: Data Base Overview and Discussion of the Domestic Data Bases
Lecture 7: Bilateral Merchandise Trade Data
Lecture 8: Other International Data Sets

Required Readings:
- Brockmeier, M. “A Graphical Exposition of the GTAP Model”, section 4, GTAP Technical Paper No. 8, Center for Global Trade Analysis, Purdue University. This can be downloaded from: http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp
- Remainder of chapter 2 in GTAP book, also chapters 3 - 5.

Supplementary Readings:
- Badri N.G., A. Aguiar, and R. McDougall, Eds. 2015. Global Trade, Assistance, and Production: The GTAP 9 Data Base, Center for Global Trade Analysis, Purdue University, chapters 1-3 (also browse through the more detailed chapters so that you know what is available) on the web at: https://www.gtap.agecon.purdue.edu/databases/v9/v9_doco.asp

Homework
Assignment 6: Exercises with Behavioral Equations

Week 7: Global Sectors, Macroeconomic Closure, and Welfare Decompositions

Lectures:
Lecture 1: Global Transport Sector
Lecture 2: Global Bank
Lecture 3: Multi-region Welfare and Terms of Trade Decomposition

Supplementary Lectures:
Lecture 4: International Transport Margins by Mode

Required Readings:

Homework
Assignment 7: Welfare Decomposition of a Trade Policy Shock

Week 8: Fall Break and Take-home Exam

Part II: Firm Heterogeneity in General Equilibrium

Week 9: The Melitz Model

Lecture:
Lecture 1: Introduction to firm heterogeneity

Required Readings:

Week 10: Alternative Trade Specifications: Armington, Krugman, and Melitz Models

Lecture:
Lecture 1: The Armington, Krugman, Melitz (AKME) Model

Required Readings:

Supplementary Readings:

Week 11: GTAP HET 1: Firm Heterogeneity in GTAP

Lecture:
Lecture 1: Implementation of firm heterogeneity in GTAP

Required Readings:

Supplementary Readings:
- Swaminathan, P. and T. Hertel, 1996. "Introducing Monopolistic Competition into the GTAP Model," GTAP Technical Paper Series #6, Center for Global Trade Analysis. This can be downloaded from https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=309

Homework:
Assignment 8: Trade Policy Analysis in the Firm Heterogeneity Model

Week 12: GTAP HET 2: Application to Regional Trade Agreements

Lecture:
Part III: Special Topics

Week 13: Estimating Confidence Intervals using Systematic Sensitivity Analysis

Lectures:
Lecture 1: Sensitivity Analysis for CGE Modeling
Lecture 2: Systematic Sensitivity Analysis – An Application

Required Readings:

Supplementary Reading:

Week 14: Climate Impacts and Mitigation Analysis

Guest Lectures

Required Readings:

Supplementary Readings:

Part IV: Synthesis and Presentations

Week 15: Putting AGE Analysis in Perspective

Required Readings:
- McDougall, R. A., 1993, Uses and Abuses of CGE Analysis, mimeo, Center for Global Trade
Week 16: Student Presentations, Synthesis and Course Wrap-up

Assignment Overview

Part I: Closed Economy Analysis: weeks 1-8

- Week 1 - Assignment 1: Viewing of Database and Numeraire Simulation
- Week 2 - Assignment 2: Walras Law
- Week 3 - Assignment 3: Producer Behavior – Conditional Elasticities of Demand
- Week 4 - Assignment 4: Analysis of Consumer Behavior
- Week 5 - Assignment 5: Welfare Effects of a Manufactures Subsidy
- Week 6 - Assignment 6: Exercises with Behavioral Equations
- Week 7 - Assignment 7: Welfare Decomposition of a Trade Policy Shock
- Week 8 - Take-home

Part II: Open Economy: weeks 9-12

- Week 9 - Assemble/Test Replication Files
- Week 10 - Replication Write-up
- Week 11 - Assignment 8: Trade Policy Analysis in the Firm Heterogeneity Model
- Week 12 - Work on Extension

Part III: Special Topics: weeks 13-14

- Week 13 - Extension Write-up
- Week 14 - Draft PPT for class presentations

Part IV: Synthesis and Presentations: weeks 15-16

- Week 15 - Final PPT for class presentations
- Week 16 - Final Write-up