

APPLIED GENERAL EQUILIBRIUM ANALYSIS
FALL SEMESTER, 2006
http://ae761-e.agecon.purdue.edu/AgEcon_618/default.asp

Instructor:

Tom Hertel, Krannert 563, Phone: 765-494-4199, Email: hertel@purdue.edu

TA:

Nelson Villoria, Krannert 634, Phone: 765-494-7939, Email: nvillori@purdue.edu

Web Support:

Ginger Batta: gbatta@purdue.edu

Course time:

Lectures offered over the web. Weekly class discussions will take place once a week for approximately one hour at 4:30pm on Monday in Rawls 1071.

Office hours:

Appointments by email. Questions and discussions on web board are encouraged.

Intended Audience:

PhD students, MS students with strong a foundation in micro-economics, and faculty in agricultural and applied economics with 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. In the past, students in other fields, such as production economics have found this course to provide them with a useful perspective.

Prerequisites:

Graduate level microeconomics (at Purdue University: ECON 511 or ECON 607).

Text:

Part I will be based on AGECE 618 course notes and supplementary readings to be handed out.

Part II will draw on: *Global Trade Analysis Using the GTAP Model*, Hertel, T.W. (editor), New York: Cambridge University Press, 1997.

Part III will draw on a series of GTAP Technical Papers, published on the web at:

https://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

Software:

Horridge, M., RunGTAP, Center for Global Trade Analysis, Purdue University, 2005.

Harrison, W.J. and K.R. Pearson, GEMPACK, version 9.0, Center for Policy Studies, Monash University, 2005.

Assignments Overview:

Weekly Homework (50% of grade) – These generally take 2-3 hours to complete and they are submitted electronically on a weekly basis.

Midterm Exam (20% of grade)

Class participation both on the web and in person (5% of grade)

Individual presentation and write-up of special project (25% of grade)

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 and environmental economics. As such, it should assist students to see how their other course work fits together.

The other objective of this course is to expose participants to an operational framework (including theory, software and data) for conducting 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 some further sensitivity analysis/extension of the work. We will follow the format used in many professional meetings, and have a fellow student serve as the discussant for each of these applications. The discussant will be responsible for replicating the speaker's new results, as well as addressing the strengths and weaknesses of the work.

The computer assignments and the course project will all be implemented in the context of version 2 of the RunGTAP software interface 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 reception to this software in previous courses has been very positive, and its use 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 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.

The GTAP Data Base we will use is amenable to a wide range of applications. It is currently in use by several thousand 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 the USDA. Current GTAP applications address issues in the areas of: trade policy reform, regional economic integration, resource and environmental economics, as well as the implications of new technology and climate change. 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

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. Then students will be required to replicate 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 class participation, as measured by participation in class discussions and in the Web-based discussion group (10%), homework assignments (40%), midterm exam (20%), individual presentation and write-up of special project (30%).

Course Overview

Part I: Closed Economy Analysis

- Week 1: Getting Started
- Week 2: Overview of the Closed Economy Model
- Week 3: Producer Behavior
- Week 4: Household Behavior
- Week 5: Markets - Supply Response
- Week 6: Markets - Equilibrium Demand Elasticities
- Week 7: Welfare Analysis in a Second-best Setting
- Midterm: Review of Closed Economy Model

Part II: Open Economy

- Week 8: Introduction to the multi-region model
- Week 9: Global Sectors, Macroeconomic Closure and Welfare Decomposition
- Week 10: Analysis of technological progress and economic growth in a global economy

Part III: Advanced Topics and Special Projects: weeks 10 - 14

- Imperfect competition and scale economies
- Climate Change Policy
- Trade and Poverty
- Systematic Sensitivity Analysis

Part IV: Synthesis and Course Wrap-up: week 15

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 read. 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 reading: These are optional.

Homework: Homework assignments are due Friday by 5pm. Check the course calendar on the website for updates.

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:

Introduction to AGE Analysis
Why General Equilibrium?

Illustrative simulation:

Introduction to RunGTAP for the one region model: OneGTAP tutorial

Required Reading:

Hertel, Thomas W., 1990. "General Equilibrium Analysis of Agriculture: What Does It Contribute?" Journal of Agricultural Economics Research, Summer issue.

Supplementary Reading:

Kehoe, P.J. and T.J. Kehoe, 1994. "A Primer on Static Applied General Equilibrium Models," *Quarterly Review*, Federal Reserve Bank of Minneapolis, Spring issue, pp. 2-16.

Homework: Viewing of database and numeraire simulation.

Week 2. Overview of the Closed Economy Model

Lectures:

Overview of the Closed Economy, GTAP Framework
Accounting Relationships in the One Region Model
Price linkage relationships
Tax/subsidy conventions
Model equations

Illustrative simulation:

Output tax shock

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 reading:

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

Francois, J. F. and C.R. Shiells, 1994. "AGE Models of North American Free Trade", chp. 1 in Francois and Shiells (eds.) *Modeling Trade Policy: Applied General Equilibrium Assessments of North American Free Trade*, New York: Cambridge University Press.

Hertel, T., 2002. "Applied General Equilibrium Analysis of Agricultural and Resource Policies", Chapter 26 in *Handbook of Agricultural and Resource Economics*, edited by Bruce Gardner and Gordon Rausser, Amsterdam: North Holland Press.

Homework: Walras Law

Week 3. Producer Behavior

Lectures:

Introduction to Producer Behavior
General and particular restrictions
The nested CES production function

Illustrative simulation:

Conditional producer response to a change in input price

Required Readings:

GTAP book: pp. 38 - 46

Keller, W.J. *Tax Incidence: A General Equilibrium Approach*. Amsterdam: North Holland, chapter 5: sections 5.1 - 5.6, 5.8 and appendix.

Supplementary reading:

Mundlak, Y. (1969) "Elasticities of Substitution and the Theory of Derived Demand," *Review of Economic Studies* pp. 225-236.

Homework: Simulating firm behavior

Week 4. Household Behavior

Lectures:

Overview of Final Demand
General and particular restrictions on consumer demand
Treatment of government and savings demands
CDE expenditure function

Illustrative simulation:

Household response to a price change. Introduction to AnalyseGE software.

Required Readings:

GTAP book, pp. 46 - 51 and 133 - 147.

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.

Keller, W.J. *Tax Incidence: A General Equilibrium Approach*. Amsterdam: North Holland, chp. 4 (sections 4.1-4.3 and appendix)

Supplementary reading:

Howe, H. 1975. "Development of the Extended Linear Expenditure System from Simple Savings Assumptions", *European Economic Review* (6):305-310.

Keller, W.J. *Tax Incidence: A General Equilibrium Approach*. Amsterdam: North Holland, chp. 8 "Public Consumption".

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: Analysis of consumer behavior

Week 5: Markets -- Supply Response

Lectures:

Supply Response
Single fixed input
Introducing factor mobility
An aside on own-use

Illustrative simulation:

Supply response to a change in producer prices

Required Readings:

Hertel, Thomas W., 1989. "Negotiating Reductions in Agricultural Support: Implications of Technology and Factor Mobility," *American Journal of Agricultural Economics*, 71(3):559-573.

Supplementary reading:

None

Homework: Determinants of supply response

Week 6: Markets -- Equilibrium Demand Elasticities

Lectures:

Market demand
Equilibrium demand elasticities
Links between AGE analysis and input-output/social accounting matrix based analysis
Dalton's Law
Partial vs. General Equilibrium closures

Guest Lecture:

Social Accounting Matrices (SAMs) by Channing Arndt

Illustrative simulation:

Market demand response to a price change

Required Readings:

Keller, W.J. *Tax Incidence: A General Equilibrium Approach*. Amsterdam: North Holland, chapter 3.

Reinert, K.A. and Roland-Holst, D.W. (1997), "Social Accounting Matrices", chapter 4 in: J.F. Francois, and K.A. Reinert, *Applied Methods of Trade Policy Analysis*. Cambridge, pp. 94-121.

Supplementary reading:

Arndt, C., H.T. Jensen, and Finn Tarp (forthcoming), “Structural Characteristics of the Economy of Mozambique: A SAM-based Analysis”, *Review of Development Economics*.

Pyatt, G. and J. Round. 1985. “Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework” chapter 9 in Pyatt, G. and J. Round eds., Social Accounting Matrices: A Basis for Planning. Washington, DC, The World Bank.

Homework: Decomposing Equilibrium Demand Elasticities and Incidence of a Subsidy

Week 7: Welfare Analysis in a Second-best Setting

Lectures:

Equivalent variation as a measure of welfare change
Welfare decomposition

Illustrative simulation:

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:

Hanslow, K., 2001. “A General Welfare Decomposition for CGE Models,” GTAP Technical Paper #19, Center for Global Trade Analysis, Purdue University. This can be downloaded from:
http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

Homework: Welfare analysis of a subsidy, review study guide

Midterm examination

Part II: Open Economy

Week 8: Introduction to the multi-region model

Lectures:

Overview
Accounting
Price Linkages
Armington structure

Required Reading:

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.

Homework: Exercises with behavioral equations

Special Project: Choose application to replicate from pre-specified list

Week 9: Global Sectors, Macroeconomic Closure and Welfare Decomposition

Lectures:

Global Transport Sector
Global Bank
Macroeconomic Closure
Multiregion welfare and terms of trade decomposition

Readings:

Dewatripont, M. and G. Michel, 1987, On Closure Rules, Homogeneity and Dynamics in Applied General Equilibrium Models, *Journal of Development Economics* 26:65-76.

Huff and Hertel, 1996 "Decomposing Welfare Changes in the GTAP Model", GTAP Technical Paper #5, part 2. This can be downloaded from:
http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

Supplementary Readings:

Francois, Joseph F., Bradley J. McDonald and Håkan Nordström Title, 1996, "Liberalization and Capital Accumulation in the GTAP Model" GTAP Technical Paper No. 7. This can be downloaded from:
<http://www.agecon.purdue.edu/gtap/techpaper/tp-7.htm>

Willenbockel, D., 1998, "Growth effects of anticipated trade liberalization and the Baldwin multiplier", *Economics Letters* (59):231-235.

McDougall, R.A. 1993. "Two Small Extensions to SALTER", SALTER Working Paper No. 12, Industry Commission: Canberra, Australia.

Homework: Welfare decomposition of a trade policy shock

Special Project: Replication of an existing study

Week 10: Analysis of technological progress in a global economy

Lectures:

- Analysis of technological progress
- Discussion of methods for construction of the global, GTAP data base

Required Readings:

Frisvold, G, 1997, "Multimarket effects of agricultural research with technological spillovers", chapter 13 in GTAP book.

Walmsley, T. and Scott McDonald 2003. "Bilateral Free Trade Agreements and Customs Unions: The Impact of the EU Republic of South Africa Free Trade Agreement on Botswana", [GTAP Working Paper, No. 29](#), Center for Global Trade Analysis.

Supplementary Readings:

Van Meijl, H. and Frank van Tongeren, 1998 "Endogenous International Technology Spillovers and Biased Technical Change in the GTAP Model", GTAP technical paper no. 15, Center for Global Trade Analysis, Purdue University. This can be downloaded from:
http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

Homework: Replication and analysis of portion of the Frisvold study, GTAP book, chapter 13 using AnalyseGE.

Part III: Special Topics and Class Project

Construction of the Global GTAP Data Base:

Required Readings:

Dimaranan, Betina V., Editor (2006). *Global Trade, Assistance, and Production: The GTAP 6 Data Base*, Center for Global Trade Analysis, Purdue University, (browse the table of contents and a few chapters so that you know what is available) on the web at:
https://www.gtap.agecon.purdue.edu/databases/v6/v6_doco.asp

McDonald, S. and Karen Thierfelder 2004. "Deriving a Global Social Accounting Matrix from GTAP Versions 5 and 6 Data", [GTAP Technical Paper, No. 22](#), Center for Global Trade Analysis.

Supplementary Reading:

Huff, Karen, Robert McDougall and Terrie Walmsley (2000), "Contributing Input-Output Tables to the GTAP Data Base", [GTAP Technical Paper No. 01](#), Center for Global Trade Analysis.

Systematic Sensitivity Analysis:

Guest Lectures by Channing Arndt and Paul Preckel

Required Readings:

DeVuyst, E.A. and P.V. Preckel, 1997, Sensitivity Analysis Revisited: A Quadrature-Based Approach, *Journal of Policy Modeling* 19(2):175-85.

Arndt, C., 1996, An Introduction to Systematic Sensitivity Analysis via Gaussian Quadrature, GTAP Technical Paper No. 2, Center for Global Trade Analysis, Purdue University, download from: <http://www.agecon.purdue.edu/gtap/techpaper/tp-2.htm>

Arndt, Channing and Thomas W. Hertel, 1997. "Revisiting the Fallacy of Free Trade," *Review of International Economics* 5(2):221-229.

Imperfect competition and Scale Economies:

Lecture:

Introduction to imperfect competition and scale economies in GTAP

Required Reading:

Elbehri, A. and T. Hertel. 2005. "A Comparative Analysis of the EU-Morocco FTA vs. Multilateral Liberalization" forthcoming in the *Journal of Economic Integration*; also published as GTAP Working Paper No. 31, This can be downloaded from: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1643

Supplementary readings:

Francois, J.F., and D. Roland-Holst, 1997, Scale Economies and Imperfect Competition, chapter 11 in: J. Francois and K. Reinert, eds., *Applied Methods for Trade Policy Analysis: A Handbook* (New York: Cambridge University Press).

Francois, J. (1998) "Scale Economies and Imperfect Competition in the GTAP Model", GTAP technical paper No. 14, Center for Global Trade Analysis, Purdue University. This can be downloaded from: http://www.gtap.agecon.purdue.edu/resources/tech_papers.asp

Climate Change Policy:

Guest Lectures: Truong P. Truong

Review of Modeling Energy-Economy Interactions

Introduction to GTAP-E

Some illustrative experiments with GTAP-E

Required Readings:

Burniaux, J-M, and T.P. Truong, 2001, GTAP-E: Incorporating Energy Substitution into the GTAP model, Technical Paper No. 16, Center for Global Trade Analysis, Purdue University, download from: <http://www.agecon.purdue.edu/gtap/techpaper/tp-16.htm>

Trade and Poverty:

Hertel, T.W. and L.A. Winters (eds.) 2006. *Poverty and the WTO: Implications of the Doha Development Agenda*. Palgrave-Macmillan and The World Bank.

Hertel, T.W., R. Keeney, M. Ivanic and L.A. Winters 2006. "Impacts of WTO Reforms on Farm Households in Rich and Poor Countries", under review with *Economic Policy*.

Part IV: Synthesis and course wrap-up

Lectures:

What you should take away from this course

Required Readings:

McDougall, R. A., 1993, *Uses and Abuses of CGE Analysis*, mimeo, Center for Global Trade Analysis, Purdue University, Working Paper No. 5, download from:
http://www.gtap.agecon.purdue.edu/resources/working_papers.asp

Powell, A.A. and R.H. Snape, 1993, "The Contribution of Applied General Equilibrium Analysis to Policy Reform in Australia," *Journal of Policy Modeling* 15(4):393-414.

Whalley, J., 1986, "Hidden Challenges in Recent Applied General Equilibrium Exercises," in: Piggott and Whalley, eds., *New Developments in Applied General Equilibrium Analysis* (New York: Cambridge University Press).

Hertel, T., 1999, *Future Directions in Global Trade Analysis*, paper presented at the Second Annual Conference in Global Economic Analysis, Fuenen, Denmark. GTAP Working paper #4, download from:
http://www.gtap.agecon.purdue.edu/resources/working_papers.asp