

UNIVERSITY OF COLORADO
BOULDER, COLORADO

Economics 4868:
Optimization and Simulation Modeling in Microeconomics

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Office: Economics Building 216,
Office Hours: T-Th 11:00-12:00 and 14:00-15:00

Course Outline and Reading List

This is a new course not only to CU Economics, and it is something I am crafting from scratch. There is no textbook or other off-the-shelf materials for it (I have taught it once). It should be of interest to students in applied math, computer science and engineering as well MM
you come to look for jobs.

The good news: there are no exams. Assessment is by problem sets and each student will be in a group project, described below. Last year's course rating was 4.9 and instructor 5.3 (out of 6). Work level was 3.7 out of 5.0. There were no complaints that the course was too difficult or demanding, though there were three who dropped rather late.

The bad news: because there is no textbook and we work through all material in class, attendance at all classes mandatory. Three missed classes results in a full grade point deduction. No kidding. There will be exercises due every second week, and it is mandatory that these all be done and done on time. There will be an exercise due the second week of class, and failing to turn any exercise in on time results in the lost of a quarter grade point.

Intermediate microeconomics, Econ 3070 is necessary (as well as formally required) for the course. The level of math required will NOT be higher than any other 4000 level economics course, nor will the work load. But the nature, requirements, and pacing of the course will be somewhat different. Indeed, there is going to be a lot of "play it by ear" and I am prepared to adapt and improvise when a need or problem be- M@

The idea behind the course is to translate economic ideas and models that are dealt with graphically and algebraically into computable, solvable simulation models. I am hoping that this will prove to be fun as well as really solidifying people's understanding of economics. We will be able to try out ideas and scenarios in order to see the quantitative effects of changes to the economy. These could include taxes and subsidies, environmental externalities, income redistribution policies, international trade restrictions and liberalizations, public goods and so forth. We will learn how to dump simulation output to excel and create graphics.

The course will use a software package called GAMS (general algebraic modeling system), a demo version which is downloadable for free - and large enough for anything we will be doing. It is already installed on all the machines in the Econ building undergraduate computer lab. GAMS is widely used by economists and engineers for optimization problems and for solving systems of equations and inequalities (e.g., GAMS is used by engineers for refinery scheduling programs, by logistics managers for airlines and shipping companies).

Look for the file "Welcome to GAMS" on my personal website for downloading and installing the software. I hope you will find it fairly easily. You can find this at:

<http://spot.colorado.edu/~markusen>

Then click on "Teaching" on the left menu

Then under "Simulation Modeling in Microeconomics", click on "GAMS Chapter 1 2012 (Jensen)"

Or you can go there directly at:

http://spot.colorado.edu/~markusen/teaching_files/applied_general_equilibrium/GAMS/intro1.pdf

I very much hope that you will do this before the first class.

By the end of the first week, you will also need to start reading

http://spot.colorado.edu/~markusen/teaching_files/applied_general_equilibrium/GAMS/intro2.pdf

I am sorry to say that GAMS doesn't work very well on Apple products, a common problem with many types of scientific computing software. Please see the GAMS website:

www.gams.com

I will also attach a guide for installing GAMS on Apple computers.

Likely method of assessment:

Exercises and problem sets:	40%	these must be done on time
Project:	40%	due at the time of the final exam
Class participation:	20%	ask interesting and challenging questions

The following are a list of topics for the lectures. For the reasons noted above, slides and exercises will be made up as we go along.

1. Installation of gams: GAMSinstallnotes.pdf
installing on your laptop, **but please do this ahead of time**
installed on machines in the Economics Building computer lab (basement)
creating a project file and directory
running gams, reading output, debugging

2. Theory light 1: profit maximization for a competitive firm: 4868 notes1.pdf
first-order condition, second-order condition, entry condition, complementarity
Models: M1-1a, M1-1b

3. Theory light 2: optimization theorems and results: 4868 notes1.pdf
Karush-Kuhn-Tucker theorem, Tells us we can convert a non-linear constrained optimization
problem into a set of equations and inequalities in matched variables.
Value functions, the envelop theorem, Shepard's lemma
Lagrangean formulation of the KKT conditions

4. Simple syntax, introduction to the solvers 4868 notes2.pdf

NLP (non-linear programming, used in constrained optimization)
MCP (mixed complementarity programming - for nxn systems of equations and inequalities
in n bounded (e.g., non-negative) unknowns)
MPEC (mathematical programming with equilibrium constraints) combines NLP and MCP:
Simple profit maximization problem of notes1 explaining complementarity

5. Introduction to complementarity 4868 notes2.pdf
example of supply and demand: three types of solutions to two inequalities and unknowns
with non-negative price and quantity
correspondence between equations and unknowns
use and interpretation of marginals (aka slack variables)
Models: M2-1a, M2-1b

6. Newton method for solving nxn non-linear problems 4868 notes2.pdf

7. Maximizing utility subject to a budget constraint 4868 notes2.pdf
 - formulated as an nlp
 - formulated as an mcp using the KKT (first-order) conditions
 - interpreting marginals as shadow values and Lagrangean multipliers
 - deriving Marshallian demand functions
 - deriving Hicksian demand functions, expenditure function
 - Models: M2-2a, M2-2b

8. Cost, profit and factor-demand functions for competitive firms 4868 notes2.pdf
 - Models: M2-3a, M2-3b

9. General equilibrium as a complementarity problem (MCP) 4868notes3.pdf
 - conditions for equilibrium: zero profits, market clearing, income balance
 - micro consistency

10. A basic two-good, two-factor general-equilibrium model 4868 notes3.pdf
 - assessing and interpreting counter-factuals
 - add taxes
 - Models: M3-1a, M3-1b, M3-1c

11. Variations on the basic model 4868 notes3.pdf

14. Taxes, distortions, public goods and bads 4868notes6.pdf
 benchmarking with taxes
 labor supply and distortionary income taxes
 equal-yield tax reform
 public consumption goods
 endogenous, optimal provision of the public good
 public infrastructure goods
 pollution externality
 Models: M6-1, M6-2, M6-3, M6-4a, M6-4b, M6-4c, M6-5, M6-6a, M6-6b, M6-6c
15. Open (trading) economy models: 4868notes8.pdf
 small open economy
 tariffs versus real trade costs
 small open economy with a benchmark tariff
 small open economy with a benchmark quota
 modeled as an endogenous tax equivalent
 modeled as a license: an artificial commodity
 Models: M8-1, M8-2, M8-3, M8-4a, M8-4b

Model list:

- M1-1a profit maximization by a competitive firm
 M1-1b profit maximization by a competitive firm - illustrates Lagrangean
 M2-1a supply and demand model illustrating mcp
 M2-1b supply and demand model - add tax
- M2-2a maximizing utility subject to a budget constraint - Marshallian formulation
 M2-2b maximizing utility subject to a budget constraint - Hicksian formulation
 M2-3a maximizing profits by a competitive firm - production function
 M2-3b maximizing profits by a competitive firm - cost function
- M3-1a general equilibrium with two goods, two factors, one consumer - Marshallian
 M3-1b general equilibrium with two goods, two factors, one consumer - Hicksian
 M3-1c general equilibrium with two goods, two factors, one consumer - adds taxes
 M3-2 general equilibrium with an initially slack activity
 M3-3a general equilibrium with a labor-leisure choice - Marshallian
 M3-3b general equilibrium with a labor-leisure choice - Hicksian
 M3-4a general equilibrium with two households
 M3-4b general equilibrium with two households - extensions
 M3-5 exercise to identify calibration errors
- M4-1 partial equilibrium monopoly model
 M4-2 oligopoly model with free entry and exit
 M4-3a Cournot competition with continuous strategies
 M4-3b Cournot competition with continuous strategies - extension
 M4-4 pure strategy Nash equilibria with discrete strategies

M5-1a	network and logistics optimization
M5-1b	network and logistics optimization - adds demand functions - nlp version
M5-1c	network and logistics optimization - adds demand functions - mcp version
M5-2	finance, optimal portfolio choice
M5-3	non-linear least squares as an NLP
M5-4	health insurance with moral hazard, adverse selection
M6-1	benchmark taxes, tax reform
M6-2	equal yield tax reform
M6-3	equal yield tax reform extended
M6-4a	public good provision
M6-4b	public good provision - optimal tax via Samuelson rule
M6-4c	public good provision - optimal tax via MPEC
M6-5	public infrastructure good
M6-6a	pollution externality
M6-6b	pollution externality - optimal tax via MPEC
M6-6c	pollution externality - optimal tax via Pigouvian formula
M8-1	small open economy
M8-2	tariffs and trade costs
M8-3	small open economy with a benchmark tariff
M8-4a	small open economy with a benchmark quota - modeled as an endogenous tax rate
M8-4b	small open economy with a benchmark quota - modeled as supply/demand for licenses

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E-mail policy: you may email me with small questions, but I tend not to answ

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