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 ˽ ˢ ajc 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- Ł ﻭ Ƽ ᴰ ᴀ ƙ l ᴐ M@ ᴀ ﻩ ˢ ˢ

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.

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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 functon
   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 hazzard, 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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