

Lecture I: Introduction and Computational Versus Analytical Economics

Charles B. Moss¹

¹University of Florida

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- 1 Course Overview
 - Purpose
 - Resources
 - Grade Components
 - Grade Scale
 - Course Outline

- 2 Computational Versus Analytical Economics

Purpose

This course introduces students to applied numerical methods in agricultural and applied economics including computable general equilibrium analysis, finite games, nonlinear prices models, dynamic programming, and welfare analysis.

- Simply Fortran: A Fortran compiler based on GNU/GCC (register for \$25).
- General Algebraic Modeling System (GAMS) (Student Version)
- LaTeX (MiKTeX at <http://miktex.org> and a user shell)
- Mathematica (Semester License)
- Visual C++ Express (Free)

Resources – Continued

- Option, but recommended
 - Aubrey, A. 2011. *Computer Structure and Logic*. Pearson Education, Inc.
 - Kendrick, D.A., P.R. Mercado, and H.M. Amman. 2005. *Computational Economics* Princeton University Press.
 - Rao, S. 2012. *Sams Teach Yourself C++ in One Hour a Day* Seventh Edition. Pearson Education, Inc.
- Moss, C.B. 2012. *Static and Dynamic Optimization for Agricultural and Resource Economics* Draft Manuscript online.

Resources – Continued

- Moss, C.B. 2012. *Static and Dynamic Optimization for Agricultural and Resource Economics* Draft Manuscript online.

Grade Components

Activity	Weight
Homework	15 %
Midterm Examination	35 %
Final Examination	45 %
Class Participation	5 %

Grade Scale

Grade	Percentage of Total Points	Numeric GPA
A	96-100	4.00
A-	92-95	3.67
B+	88-91	3.33
B	84-87	3.00
B-	80-83	2.67
C+	76-79	2.33
C	72-75	2.00
C-	68-71	1.67
D+	64-67	1.33
D	60-63	1.00
D-	56-59	0.67
E	0-55	0

Course Outline

- Basics of computational analysis
 - Some Examples of Computational Analysis
 - Purvis, A., W.G. Boggess, C.B. Moss, and J. Holt. 1995. Technology Adoption Decisions Under Irreversibility and Uncertainty: An *Ex Ante* Approach. *American Journal of Agricultural Economics* 77(3), 541-551.
 - Moss, C.B. 2012. Cash Versus Market Value Balance Sheets: A Stochastic Dynamic Approach. Working Paper, Department of Food and Resource Economics, University of Florida.
 - Moss, C.B. and T.G. Schmitz. 2011. The Potential Effect of Ethanol on the U.S. Economy: A General Equilibrium Approach. In *The Economics of Alternative Energy Sources and Globalization* eds A. Schmitz, N. Wilson, C.B. Moss, and D. Zilberman. Bentham eBooks, 35-49.

Course Outline – Continued

- Mathematics on computers
 - Computer Structure and languages
- Integration Techniques
- Numerical techniques for solving nonlinear systems
- Numerical optimization
- Software Applications
 - Zenios, S.A. 1996. Modeling Languages in Computational Economics: GAMS. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 471-488.
 - Varian, H.R. 1996. Mathematica for Economists. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 489-505.

Course Outline – Continued

- Computable General Equilibrium
 - Dixon, P.B. and B.R. Parmenter. 1996. Computable General Equilibrium Modeling for Analysis and Forecasting. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 3-85.
- Finite Games
 - McKelvey, D. and A. McLennan. 1996. Computation of Equilibria in Finite Games. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 87-142.
- Nonlinear Pricing and Mechanism Design
 - Wilson, R. 1996. Nonlinear Pricing and Mechanism Design. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 87-254.

Course Outline – Continued

- Approximation in Economic Analysis
 - Judd, K.L. 1996. Approximation, Perturbation, and Projection Methods in Economic Analysis. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 509-585.
- Dynamic Analysis
 - Rust, J. 1996. Numerical Dynamic Programming in Economics. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 620-726.
- Agent Based Models
 - Tesfatsion, L. 1996. Agent-Based Computational Economics: A Constructive Approach to Economic Theory. In *Handbook of Computational Economics* eds. Amman, H.M., D.A. Kendrick, and J. Rust. Elsevier, 831-880.

Computational Versus Analytical Economics

As a starting point, let's think about what you have typically done in your theory classes up to this point. Take the derivation of producer behavior

$$\begin{aligned} \max_x & p'y - w'x \\ \text{s.t. } & \{y, x\} \in T \end{aligned} \tag{1}$$

where y is a vector of outputs, p is a vector of output prices, x is a vector of input levels, and w is a vector of input prices.

Cobb-Douglas Production Function

In order to be a little more concrete, let's replace the production technology with a Cobb-Douglas production function of a single output with three inputs

$$\max_x p x_1^{\alpha_1} x_2^{\alpha_2} x_3^{\alpha_3} - w_1 x_1 - w_2 x_2 - w_3 x_3 \quad (2)$$

Given this formulation, we are interested in the economic behavior embodied in this formulation.

Economic Plans of Work

Q1 Does a solution exist?

- Demonstrate that a solution obeys the first and second order necessary conditions.
- Demonstrate under what conditions the problem can obey the first and second order necessary conditions.

Q2 Is that solution Unique?

- Demonstrate first and second order sufficient conditions.

Economic Plans of Work – Continued

- Q3 As the point of the solution can you say something about the implied behavior – Demand curves slope downward.
- In both of these pursuits the formulation in Equation 2 allows for a closed form or analytical solution.
 - Pages 15-17 of my production book demonstrates the derivation of the cost function for the two-input Cobb-Douglas production function

$$\begin{aligned}
 x_1^*(w_1, w_2, y) &= y^{\frac{1}{\alpha + \beta}} \left(\frac{\alpha w_2}{\beta w_1} \right)^{\frac{\beta}{\alpha + \beta}} \\
 C(w_1, w_2, y) &= y^{\frac{1}{\alpha + \beta}} w_1^{\frac{\alpha}{\alpha + \beta}} w_2^{\frac{\beta}{\alpha + \beta}} \left[\left(\frac{\alpha}{\beta} \right)^{\frac{\beta}{\alpha + \beta}} + \left(\frac{\beta}{\alpha} \right)^{\frac{\alpha}{\alpha + \beta}} \right] \quad (3)
 \end{aligned}$$

Economic Plans of Work – Continued

Q3 Implied Behavior

- We can take the derivative of the derived demand functions and demonstrate that they slope downward in own input price.
- We can take the derivative of the cost function with respect to the level of output to demonstrate that cost is increasing at an increasing rate.

Numerical Plan of Attack

- The point here is what if the production function has no closed form solution?

$$f(x_1, x_2) = \ln(\alpha_1 x_1 + \alpha_2 x_2 + A_{12} x_1 x_2) + \beta_1 x_1 + \beta_2 x_2 + B_{12} x_1 x_2 \quad (4)$$

- Can we solve for this optimal numerically and then use other numerical methods to describe the optimal behavior?