COMPUTATIONAL ECONOMICS

This course covers the specification, computation, estimation and interpretation of structural models that are widely used in applied microeconomics (empirical and theoretical Industrial Organization, public and urban economics, environmental economics, development, political economy (e.g., voting), health and education economics, trade) and Marketing. Our focus will be on how to use these models in practice, and students will solve and estimate models in weekly problem sets, with solutions/code being discussed in class. While some advanced computational methods will be discussed, we will also look at models that can be estimated in user-friendly programming environments such as STATA, and we will emphasize how the type of structural models discussed can complement more straightforward regression analyses. To motivate the models that we consider we will also discuss some analytic theory and reduced-form empirical work that may not be covered in other classes.

NB. While some familiarity with a programming language such as GAUSS, MATLAB or R will be required to do the problem sets, great expertise is not required. Consistent with this, the emphasis will be on models and methods that a significant number of students will likely want to use in applied work rather than providing tools that are only likely to be used by the computational specialist.

Contact details: my permanent office will be Tydings 3135, telephone number 301-405-8325. Until I move into it I will be in Tydings 4115C, but the telephone number should work.

Assessment/grading: will be based on weekly problem sets (50%) and a final exam (50%, a paper can be submitted instead). Unfortunately the final exam is on Saturday, December 21 8:00-10:00am.

Office hours: Tuesday 9:30-11, but we can make a separate arrangement if you have a well-defined question. Problem sets will normally be due on Wednesdays. Ideally I would like to discuss problem set questions in class on Mondays, so that everyone can hear the question and the answer.

Materials: I will distribute lecture slides prior to class. The vast majority of the material is on these slides, but in some cases I will also ask you to do some reading prior to class.

There is no required textbook. However, there are some useful books that you may want to look at.

For background on computational techniques:
Ken Train, Discrete Choice Methods with Simulation, available on his Berkeley website (especially useful for demand/single-agent choice models).
Mario Miranda and Paul Fackler, Applied Computational Economics and Finance, 2004 (note there is a computational economics toolbox for MATLAB that accompanies the book).
For background on empirical issues:
Peter Davis and Eliana Garces, *Quantitative Techniques for Competition and Antitrust Analysis*, Princeton, 2010 (an excellent guide to how economics and econometrics are used in the real-world).
William Greene, *Econometric Analysis* or Jeffrey Wooldridge, *Econometric Analysis of Cross-Section and Panel Data* (econometric references)

Auction specialists should get a copy of:

If you are taking IO as a field, you should also look at:
Jean Tirole, *The Theory of Industrial Organization*, MIT, 1987 (a must-have and a must-read if you want to do IO research).

Three useful Handbook chapters are:
U Dorazelski and A Pakes, A Framework for Applied Dynamic Analysis in IO
J Rust, Numerical Dynamic Programming

**Attendance:** if you plan to miss more than one or two lectures please let me know. Students interested in IO should attend the Tuesday afternoon seminar.
OUTLINE AND READINGS

The course is divided into 5 parts, reflecting different types of models. In the process of covering a particular type of model we will discuss some more general computational issues that we will see again in later parts of the course, often in more complicated settings. The following table gives a rough idea how the economic and computational topics are going to mix:

<table>
<thead>
<tr>
<th>Modeling Topic</th>
<th>Computational/Econometric Topics</th>
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</table>
| 1. Static Single Agent Choice Models/Demand | Optimization  
Solving nonlinear equations  
Numerical integration using simulation  
MPEC  
Moment inequalities |
| 2. Static Games (i.e., multi-agent choice models) | Solving nonlinear equations  
Homotopy methods for finding all solutions  
Two-step estimation methods  
Moment inequalities |
| 3. Auction Models | Solving differential equations |
| 4. Dynamic Single Agent Choice Models/Demand | Dynamic programming with discrete state spaces  
Dynamic programming with continuous action spaces (approximation)  
Importance sampling |
<p>| 5. Dynamic Games | More on homotopy methods and two-step techniques; continuous time |</p>
<table>
<thead>
<tr>
<th></th>
<th>Dates</th>
<th>Topics</th>
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<tbody>
<tr>
<td>1</td>
<td>4-Sep</td>
<td>Introduction and overview. Motivation of demand estimation.</td>
</tr>
<tr>
<td>2</td>
<td>9-Sep</td>
<td>Homogenous Products Demand and Instruments</td>
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<tr>
<td>3</td>
<td>11-Sep</td>
<td>Differentiated Product Demand Models: AIDS, Logit, Nested Logit</td>
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<td>4</td>
<td>16-Sep</td>
<td>Differentiated Product Demand Models: Random Coefficients</td>
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<td>5</td>
<td>18-Sep</td>
<td>MPEC</td>
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<tr>
<td>6</td>
<td>23-Sep</td>
<td>Moment Inequalities</td>
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<td>7</td>
<td>25-Sep</td>
<td>Dealing with endogenous product characteristics</td>
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<tr>
<td>8</td>
<td>30-Sep</td>
<td>Cournot and Bertrand oligopoly games</td>
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<td>9</td>
<td>2-Oct</td>
<td>Theoretical models of market entry; endogenous sunk costs.</td>
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<td>10</td>
<td>7-Oct</td>
<td>Discrete choice entry models, complete information: Bresnahan and Reiss, Berry.</td>
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<tr>
<td>11</td>
<td>9-Oct</td>
<td>Discrete choice entry models, incomplete information: Seim.</td>
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<tr>
<td>12</td>
<td>14-Oct</td>
<td>Methods for dealing with multiple equilibria: two-step, mixtures, inequalities, homotopy</td>
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<tr>
<td>13</td>
<td>16-Oct</td>
<td>Methods for dealing with multiple equilibria: two-step, mixtures, inequalities, homotopy</td>
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<tr>
<td>14</td>
<td>21-Oct</td>
<td>Introduction to auctions</td>
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<tr>
<td>15</td>
<td>23-Oct</td>
<td>Solution of first price auction models</td>
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<td>16</td>
<td>28-Oct</td>
<td>Estimation of auction models (GPV)</td>
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<td>17</td>
<td>30-Oct</td>
<td>Auction models with entry and selection</td>
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<tr>
<td>18</td>
<td>6-Nov</td>
<td>Solving a single agent DP model (value and policy iteration)</td>
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<td>19</td>
<td>11-Nov</td>
<td>Estimating a single agent DP model using NFXP</td>
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<td>20</td>
<td>13-Nov</td>
<td>Estimating a single agent DP model using NFXP with value function approximation</td>
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<td>21</td>
<td>18-Nov</td>
<td>Estimating a single agent DP model using importance sampling</td>
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<td>22</td>
<td>20-Nov</td>
<td>CCP methods</td>
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<td>23</td>
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<td>CCP methods</td>
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<td>24</td>
<td>27-Nov</td>
<td>Ericson-Pakes and Pakes-McGuire</td>
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<td>25</td>
<td>2-Dec</td>
<td>Solving a dynamic game; multiple equilibria and homotopy.</td>
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<td>26</td>
<td>4-Dec</td>
<td>Estimating a dynamic game</td>
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<tr>
<td>27</td>
<td>9-Dec</td>
<td>Estimating a dynamic game</td>
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<tr>
<td>28</td>
<td>11-Dec</td>
<td>Estimating a dynamic game</td>
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READINGS

PART I. Static Single Agent Choice Models/Demand


Main Readings and Applications:

Davis and Garces, Chapter 9, 6.2


Additional Readings:

T. Bresnahan, “The Oligopoly Solution is Identified”, Economics Letters, 1980, 10, 87-92 (the following paper by Lau is also relevant)


G. Ellison, “Theories of Cartel Stability and the Joint Executive Committee”, RJE, Spring 1994, 37-57 (follow up to the Porter paper)


PART II.  Static Games

Coverage: solving Bertrand and Cournot games (continuous choices). Theoretical models of market entry (incl. Sutton/one smart agent’). Specification and estimation of entry models (discrete choice), with symmetric or asymmetric players and different information assumptions. Multiple equilibria and how to deal with them. Two step and full solution methods.

Main Readings and Applications:

Davis and Garces, p. 256-282


Tirole, chapters 7, 8

N.G. Mankiw and M.D. Whinston, “Free Entry and Social Inefficiency,” RJE, 1986, 48-58,


S. Berry, “Estimation of a Model of Entry in the Airline Industry”, Econometrica, 1992, 889-918,


Additional Readings:

J. Sutton, Sunk Costs and Market Structure, 1991, MIT Press, chapters 1-3 and industry studies in chapters 6, 8, 9


(more details of Sutton’s model of the size distribution are contained in Technology and Market Structure and an LSE STICERD working paper EL/9 “The Size Distribution of Businesses, Part I”, 1995)

T. Dunne, M. Roberts and L. Samuelson, “Patterns of Firm Entry and Exit in US Manufacturing”, 1988, RJE, 495-515,


P. Ellickson, “Supermarkets as A Natural Oligopoly”, mimeo, 2004


S. Berry and J. Waldfogel, “Free Entry and Social Inefficiency in Radio Broadcasting” Rand Journal of Economics, 30 (Autumn 1999), 397-420


K. Ho, “Insurer-Provider Networks in the Medical Care Market”, AER, 2008
PART III. Auction Models

Coverage: solving and estimating first-price auction models with and without unobserved heterogeneity, with and without selective entry.

H Paarsch, H Hong and M Ryan Haley, An Introduction to the Structural Econometrics of Auction Data, 2006, MIT Press


V Bhattacharya, J Roberts and A Sweeting, “Regulating Bidder Participation in Auctions”, 2013

J Roberts and A Sweeting, “When Should Sellers Use Auctions?”, AER, forthcoming

PART IV. Single-Agent Dynamic Choice Models


Main Readings and Applications:


Additional Readings:


PART V  Dynamic Games

Coverage: solving dynamic games and trying to find all of the equilibria (homotopy methods). Estimation of dynamic games using two-step methods and evidence on their performance (BBL, POB, MPEC, AM). Continuous time and oblivious equilibria as methods for simplifying the solution of dynamic games.

Main Readings and Applications:


S. Berry, M. Ostovsky and A. Pakes, “Simple estimators for the parameters of discrete dynamic games (with entry/exit examples)”, RAND, 2007, 373-399


G Weintraub, C L Benkard and B Van Roy, “Markov Perfect Industry Dynamics with Many Firms”, 76(6), 2008, 1375-1411


U Dorazelski, D Besanko, Y Kryukov, “The Economics of Predation: what Drives Pricing when there is Learning-By-Doing?”, AER, forthcoming

Additional Readings:


A. Collard-Wexler, “Demand Fluctuations and Plant Turnover in Ready-Mix Concrete”, Econometrica, forthcoming

C. Snider, “Predatory Incentives and Predation Policy: The American Airlines Case”, UCLA,
