DIW Masterclass
DYNAMIC GAMES: NUMERICAL METHODS AND APPLICATIONS
Location: DIW Berlin, Mohrenstr. 58, 10117 Berlin
Meeting Time: Mon. July 4, 2016, 14:00-17:30 (Dulles Room, 5.2.010)
and Tue. July 5, 2016, 9:00-12:30 (Schmoller Room 1.2.026)
Professor Ulrich Doraszelski, University of Pennsylvania

CONTACT INFORMATION AND OFFICE HOURS

You can reach me by email at doraszelski@wharton.upenn.edu.

I am holding office hours on Fri. July 1, 2016, 14:00-16:00 in TBA. You can also see me during most of July and August 2016 while I am visiting ESMT. Just email me to set up a time.

COURSE DESCRIPTION

The objective of this course is to introduce students to dynamic games and their applications in economics, with an emphasis on industrial organization. During the course we will solve a simple version of the Ericson & Pakes (1995) model of industry dynamics and discuss how to extend it to capture key features of real-world industries. We will discuss some of the existing methods for computing equilibria of dynamic games and about ways to alleviate the computational burden.

READINGS

Simple versions of the Ericson & Pakes (1995) model similar to the one that we will solve in class can be found in:

- Besanko, D. & Doraszelski, U. (2004) "Capacity Dynamics and Endogenous Asymmetries in Firm Size" *Rand Journal of Economics* 35 (1) pp. 23-49
- Doraszelski, U. & Markovich, S. (2007) "Advertising Dynamics and Competitive Advantage" *Rand Journal of Economics* 38 (3) pp. 557-592

Please read one of these two papers (available on my homepage) in preparation for the course. For an overview of the literature please further read (also available on my homepage):

- Doraszelski, U. & Pakes, A. (2007) "A Framework for Applied Dynamic Analysis in IO" in Armstrong, M. and Porter, R. *Handbook of Industrial Organization, Volume 3* North-Holland pp. 1887-1966

Additional readings are given below. These are largely optional in case you are interested in pursuing a particular topic.

PROBLEM SET

I will distribute a problem set at the end of Day 1. The problem set is meant to give you an opportunity to practice the material we covered in class. The goal is for you to code a simple version of the Ericson & Pakes (1995) model. We will discuss the solution to the problem set at the beginning of Day 2. Feel free to work on the problem set in groups of 2 to 3 people.

SOFTWARE

The default computer language for the course is Matlab and I expect that you are at least somewhat familiar with Matlab or some other matrix-oriented programming language such as Gauss.

The complete documentation of Matlab and its toolboxes can be freely downloaded at www.mathworks.com.
A tutorial to get you started and programming tips are available at
www.mathworks.com/access/helpdesk/help/pdf_doc/matlab/getstart.pdf
www.mathworks.com/access/helpdesk/help/pdf_doc/matlab/programming_tips.pdf.

SCHEDULE

Below is a draft schedule that is subject to change.

DAY 1: MON. JULY 4, 2016

Topics:

- From dynamic programming to dynamic games
- Application: Quality ladder model without entry/exit
- Markov-perfect industry dynamics
- Existence, purification, and multiplicity of equilibrium
- Application: Quality ladder model with entry/exit
- Application: Learning-by-doing

Additional Readings:

- Doraszelski, U. & Satterthwaite, M. (2010) "Computable Markov-Perfect Industry Dynamics" *Rand Journal of Economics* 41 (2) pp. 215-243
- Pakes, A. & McGuire, P. (1994) "Computing Markov-Perfect Nash Equilibria: Numerical Implications of a Dynamic Differentiated Product Model" *Rand Journal of Economics* 25 (4) pp. 555-589
- Ericson, R. & Pakes, A. (1995) "Markov-Perfect Industry Dynamics: A Framework for Empirical Work" *Review of Economic Studies* 62 pp. 53-92
- Besanko, D., Doraszelski, U., Kryukov, Y. & Satterthwaite, M. (2010) "Learning-by-Doing, Organizational Forgetting, and Industry Dynamics" *Econometrica* 78 (2) pp. 453-508

DAY 2: TUE. JULY 5, 2016

Topics:

- Discussion of problem set
- Computing all equilibria: Homotopy method
- Computational burden
- Oblivious equilibrium
- Continuous-time stochastic games with finite states
- Discrete-time stochastic games with alternating moves and finite states
- Open questions

Additional Readings:

- Borkovsky, R., Doraszelski, U., & Kryukov, Y. (2010) "A User's Guide to Solving Dynamic Stochastic Games Using the Homotopy Method" *Operations Research* 58 (4) pp. 1116-1132
- Pakes, A. & McGuire, P. (2001) "Stochastic Algorithms, Symmetric Markov Perfect Equilibrium, and the 'Curse' of Dimensionality" *Econometrica* 69 (5) pp. 1261-1281
- Weintraub, G., Benkard, L. & Van Roy, B. (2008) "Markov Perfect Industry Dynamics With Many Firms" Econometrica 76(6) pp. 1375--1411
- Doraszelski, U. & Judd, K. (2011) "Avoiding the Curse of Dimensionality in Dynamic Stochastic Games" *Quantitative Economics* 3(1) pp. 53-93
- Doraszelski, U. & Judd, K. (2007) "Dynamic Stochastic Games with Sequential State-to-State Transitions"