**Mini Course**

**Dynamic Games: Numerical Methods and Applications**

**Location: Tel Aviv University, Eitan Berglas School of Economics, Room 101**

**Meeting Time: December 11, 13, 14 & 18, 2016**

**Professor Ulrich Doraszelski, University of Pennsylvania**

**Contact Information**

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

**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 in preparation for Day 1 of the course. For an overview of the literature please further skim:

* 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-Hollandpp. 1887-1966

In preparation for Day 3, please read:

* Besanko, D., Doraszelski, U., Kryukov, Y. & Satterthwaite, M. (2010) “Learning-by-Doing, Organizational Forgetting, and Industry Dynamics” *Econometrica* 78 (2) pp. 453-508

The above readings are available on my homepage for you to download.

Additional references 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 on 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 problem set in class on Day 2.

**Take-Home Exam**

There will be a take-home exam that I will distribute at the end of class on Day 4. You have 24 hours to complete the exam and email your solution to me.

**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](http://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](http://www.mathworks.com/access/helpdesk/help/pdf_doc/matlab/getstart.pdf)

[www.mathworks.com/access/helpdesk/help/pdf\_doc/matlab/programming\_tips.pdf](http://www.mathworks.com/access/helpdesk/help/pdf_doc/matlab/programming_tips.pdf).
Please install Matlab on your laptop and bring your laptop to class.

**Schedule**

Below is a draft schedule that is subject to change.

**Day 1: Sun. December 11, 2016, 16:00-19:00**

Topics:

* From dynamic programming to dynamic games
* Application: Quality ladder model without entry/exit

Additional Readings:

* 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

**Day 2: Tue. December 13, 2016, 9:00-12:00**

Topics:

* Discussion of problem set
* Markov-perfect industry dynamics
* Application: Capacity accumulation
* Application: Advertising dynamics
* Markov-perfect industry dynamics
* Existence, purification, and multiplicity of equilibrium
* Application: Quality ladder model with entry/exit

Additional Readings:

* Doraszelski, U. & Satterthwaite, M. (2010) “Computable Markov-Perfect Industry Dynamics” *Rand Journal of Economics* 41 (2) pp. 215-243
* Ericson, R. & Pakes, A. (1995) “Markov-Perfect Industry Dynamics: A Framework for Empirical Work” *Review of Economic Studies* 62 pp. 53-92

**Day 3: Wed. December 14, 2016, 9:00-12:00**

Topics:

* Symmetry and anonymity
* Multiple equilibria
* Application: Learning-by-doing

**Day 4: Sun. December 18, 2016, 16:00-19:00**

Topics:

* Computing all equilibria: Homotopy method
* Computational burden
* 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”
* Doraszelski, U. & Escobar, J. (2016) “Protocol Invariance and the Timing of Decisions in Dynamic Games”