PSC 585: Dynamic Models – Structure, Computation, & Estimation

Spring 2016
TR 10:00-12:00
Harkness 329

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Dynamic considerations are becoming increasingly important in the study of such political processes as legislative policy making, elections and the interaction of political and macroeconomic cycles, stability of international systems, the conduct of war, etc. The course provides theoretical and computational tools for the analysis and estimation of models of strategic interaction with an emphasis on dynamic games. In the first half of the course theory and numerical methods for Markov chains, dynamic programming, and dynamic games are covered in some detail. In the second half we focus on the formulation and estimation of dynamic structural models with an emphasis on efficient numerical algorithms. Applications are drawn from legislative environments, elections, and international relations. Special attention is devoted to models of multilateral bargaining. The goal of the course is to equip graduate students with analytical tools and numerical techniques that can be used in their future research on applied topics.

Political science students are expected to have taken the first-year sequence in formal theory, PSC 407 and 408, as well as PSC 584. Some familiarity with a programming language is a plus, but the dedicated student should be able to acquire basic programming skills needed for the course. MATLAB will be the default programming language in class and for assignments. The textbook by Miranda and Fackler offers a *MATLAB Primer* in the appendix to get you started if you are unfamiliar with this environment.

There will be approximately bi-weekly homework assignments and a final exam. Each assignment will encompass a mix of theoretical and applied problems with an emphasis on the latter. You will be expected to write your own code and implement numerical methods related to the various course topics. Once during the semester you will also team up with fellow classmates in order to present a comparative assessment of submitted assignment computer code in class.

There are three textbooks for the course.

- N. Stokey and R. Lucas with E. Prescott (1989) *Recursive Methods in Economic Dynamics,* Cambridge, MA: Harvard University Press.

- M. Miranda and P. Fackler (2002) *Applied Computational Economics and Finance,* Cambridge, MA: MIT Press.

- K. Judd (1998) *Numerical Methods in Economics,* Cambridge, MA: MIT Press.

The books by Judd and Miranda and Fackler are also available online via the University library. Referenced articles are available electronically via JSTOR or similar electronic sources.

The content of the course is broken into five sections. Additional numerical methods and applications are interspersed throughout the semester. In the highly unlikely case that time permits we will consider additional topics mentioned at the end of the list.

Because the course draws from a diverse pool of literatures in Political Science, Economics, Operations Research, Computer Science, and Statistics, some choices must be made as to depth of coverage of various topics. First, necessary numerical methods are introduced when needed instead of in a separate dedicated segment of the course. You can expect fairly complete coverage of linear and non-linear equation solvers, numerical optimization, integration, and function interpolation and approximation. Second, in the interest of getting to structural estimation earlier and leaving enough time for applications, we will place an emphasis on the finite state space theory of Markov chains and Dynamic programming, providing shorter but informative overviews of the new issues that arise in the continuous state space as needed. Third, some of the topics and readings referenced below are mathematically demanding. Mathematical background will be provided as necessary throughout the course and, where appropriate, simplified versions of the readings will be presented.

SCHEDULE

Topic 1 Markov chains

Finite and infinite state spaces. Classification of states. Long-term stability. Invariant distributions. Spectral Theory. Strong Law of Large Numbers.

Related readings: Stokey-Lucas-Prescott, chapters 11, 14. Miranda and Fackler, chapter 5. Judd, chapter 7. Class notes. [13], [21], [48], [53], [63], [64].

Topic 2 Dynamic Programming

Finite and infinite state space. Bellman equation. Principle of optimality. Uncertainty. Value iteration. Policy iteration. Gauss-Jacobi and Gauss-Seidel. Error bounds. Approximate policy iteration.

Related readings: Stokey-Lucas-Prescott, chapters 4, 9. Miranda and Fackler, chapters 7.1, 8.1-8.4. 12.1. Miranda and Fackler, chapters 6. Judd, chapters 6, 11, 12. [58], [60]. Class notes.

Topic 3 Dynamic Games

Stochastic games. Determinacy of equilibrium and equilibrium outcome distributions. Structure theorems. Computation of Nash equilibrium. Homotopy methods.

Related readings: Miranda and Fackler, chapter 8.5. Class notes. [17], [22], [23], [27], [28], [31], [41]. Miranda and Fackler, chapter 9. Judd, chapters 4.9, 5. [12], [14], [19], [24], [25], [29], [33], [32], [30], [44], [55],[65], [66],[67].

Topic 4 Dynamic Structural Models

Dynamic Discrete Choice models. The Generalized Extreme Value distribution model. Dynamic Quantal Response Equilibrium. Identification. Maximum Likelihood. Two- and n-step estimators. Minimum distance, GMM, MSM estimators. The MPEC approach.

Related readings: Class notes. [2], [11], [6], [26], [37], [40], [42], [43], [45], [54], [58], [61]. [1], [3], [4], [5], [8], [9], [10], [20], [35], [34], [36], [39], [49], [50], [51], [52], [56], [57], [59], [62].

Topic 5 Bargaining Games

Structure. Computation. Identification and Estimation.

Related readings: Class notes. [46], [15], [47], [18], [38]. More class notes.

Additional Topics: Large State Spaces, Continuous Time Models

Equilibrium notions for models with large state space. Models of continuous time.

Related readings: [68], [69]. Miranda and Fackler, chapter 10-11. [7], [16].

References

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