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GAME THEORY IN THE SOCIAL SCIENCES

Political Science 135/Econ 110
Thursday 5-8 PM
Li Ka Shing 245

Instructor and readers

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Introduction

The course introduces some of the central topics in game theory—a framework for analyzing what happens when decision-makers (coworkers, managers, presidents, spouses…) interact. Over the past fifty years, game theory has gradually become a standard language in economics. Its power lies in its generality and mathematical precision; because it is both rich and crisp, game theory applies to a wide range of social, (geo)political, and economic contexts. However, its broader adoption outside of economics has been hampered by the misconception that it requires elaborate or advanced mathematics.

As Robert Aumann, the 2005 Nobel Laureate in Economics, "for having enhanced our understanding of conflict and cooperation through game-theory analysis," put it: "...game theory is a sort of umbrella or 'unified field' theory for the rational side of social science, where 'social' is interpreted broadly, to include human as well as non-human players (computers, animals, plants)." As I hope you'll come to see, game theory is not only a normative theory (how people ought to choose), but also a descriptive theory (how people actually choose), and even a prescriptive theory (a practical aid to decision-making).

A "game" is a strategic situation—one in which the best course of action for each "player" depends on what others are likely to do, and vice versa. Strategic interaction arises whenever choices are interdependent. Some recent examples include:

- In a crowded primary campaign, a second-tier candidate's decision to attack the frontrunner may hinge on whether they expect other second-tier candidates to do the same.
- As tensions escalate between two countries, a state's decision to shoot down a drone or seize a tanker hinges not only on legal or tactical considerations, but on how it anticipates the other state will respond.

- Former Speaker of the House Nancy Pelosi noted that one reason for not pursuing impeachment was the near certainty that the Senate would not convict and remove the President—highlighting strategic calculation.
- Facebook, according to a report in the NYT, has taken steps to make itself harder to break up, anticipating potential regulatory actions to disentangle its core businesses by the Federal Trade Commission.

A question game theorists often hear is what is game theory good for, or more precisely, is game theory meant to predict what decision-makers do, to give them advice, or what?! The answer is that (only) the tools of analytical game theory can be used to *predict*, *postdict* (explain), and even *prescribe*, taking into account that even if game theory is not always accurate, descriptive failures are prescriptive opportunities…

Game theory is now widely used in economics, political science, and other social sciences to model strategic interaction. This course offers a non-technical introduction to game theory, with a special emphasis on examples and applications drawn from these fields. When applying game theory in practice—not just in theory—we should remember that a precise framework can be brutally honest and provoke candid, sometimes difficult, discussions. That's why it's essential to respect others' perspectives, even when they differ significantly from our own, and to foster an environment where everyone feels safe, heard, and welcome.

Readings

The course will rely on handouts available for download in PDF format from the bCourses site, listed as "PS135/Econ110." These notes will contain all the material covered in class. Students officially enrolled should already have access. If you are on the waitlist, feel free to contact me, and I'll add you to the site. Handouts and problem sets will be posted there throughout the term. Please check the site before each lecture to see if materials have been uploaded for that session.

- The recommended textbook is Prajit Dutta, *Strategies and Games* (MIT Press). This book presents the main topics of game theory at a level suitable for our purposes and emphasizes the theory's foundations as well as recent topics in game-theoretic research.
- An excellent book for those with a good background in calculus and looking for a somewhat more challenging text is Steven Tadelis, *Game Theory: An Introduction* (Princeton University Press). Another excellent more technical book is Martin Osborne, *An Introduction to Game Theory* (MIT Press). These books provide precise definitions and proofs of a broad range of results.
- These books are lighter reading on game theory: (1) Avinash Dixit and Barry Nalebuff, *The Art of Strategy* (WW Norton), and (2) Adam Branderburger and Barry Nalebuff, *Co-opetition* (Currency Doubleday).

Problem sets

The course will rely heavily on problem sets. Each week, a new set will be assigned and generally due the following week. A detailed answer key will be provided. These problem sets are designed as learning tools—they will not be collected and graded and will not count toward the course grade. All questions in the problem sets are considered required material. I strongly encourage you to work on them together. Please do not fall behind: each topic builds on the previous one and skipping problem sets will quickly leave you struggling to keep up. My working assumption is that carrots and sticks aren't necessary to foster learning, participation, and discussion. Curiosity and collaboration should be enough.

Lectures' attendance and recording

Attendance is not mandatory—learning cannot be forced. That said, lecture recordings will be made available only with a doctor's note for catching up after illness. I encourage you to attend in person whenever possible. The classroom environment is designed to foster discussion and shared insight that cannot be replicated. If you do miss a lecture, I recommend connecting with classmates to stay current and engaged.

More specifically, we do not provide lecture recordings because the course prioritizes active engagement, intellectual presence, and community learning. Learning is not passive: Ideas unfold in real time, shaped by questions, reactions, and spontaneous insights. Being present matters. And we value commitment: Students who enroll are choosing to show up—not just physically, but intellectually and socially. There are plenty of students on the waitlist. So if you're not fully committed to showing up and participating, do the altruistic thing: give your spot to someone who is.

Exams

The requirements for a grade in the class are in-class, closed-notes midterm exam and final exam. The exams are noncumulative and have equal weight. There are no alternative exam dates and/or makeup exams. The exams will test your basic knowledge of the course material and your ability to apply this material to new problems. The midterm exam will take place during class time on Thu Oct 16, and the final exam will take place at the designated time during the final examination period.

Office hours

The readers are your first line of defense. Instructor's office hours are by appointment only and should be scheduled after meeting with the readers. Further details on office hours and the signup process will be provided in the first lecture. Feel free to reach out with any questions. You can email us or message us via the bCourses system, and we'll do our best to respond promptly. However, questions beyond simple clarification cannot be addressed effectively over email and should be brought to office hours. If you run into any trouble, don't worry—there are plenty of opportunities for support throughout the course.

Outline of topics

The course covers non-cooperative game theoretic models, which are those in which the set of actions of individual players is the primitive of the analysis (by contrast to cooperative models in which the sets of joint actions of groups of players are primitives). The course is divided into four parts:

I. Static Interactions and Strategic-Form Games.
II. Dynamic Interactions and Extensive-Form Games.
III. Repeated Games
IV. Asymmetric Information and Signaling Games.

I. Static Interactions and Strategic-form Games: A static situation is one in which each actor must make one decision and does so in ignorance of what the other actors are doing. For example, two firms may have to decide how much to invest in R&D at the same time or two states may secretly decide how much to spend on defense. Sealed-bid auctions are also static interactions. In this part of the course, we will see how these situations can be represented as strategic-form games and how we can solve these games.

A. The definition and some examples of strategic-form games.
B. Dominance Arguments.
C. Nash Equilibria.

Readings: Ch 3 (skip section 3.1.2); Ch 4: pp. 49-53, 55-59; Ch 5; Ch 6: 75-84; Ch 7, Ch 8: 103-108, 110-115.

II. Dynamic Interactions and Extensive-Form Games: An interaction is dynamic if at least one actor can respond to another actor's decisions when making her/his decision. Bargaining between a buyer and seller is dynamic. The buyer can decide how to revise its previous offer considering the seller's latest offer. Arms races are also dynamic. A state can decide how much to spend this year considering what the other side did last year. Extensive-form games provide a natural setting for the analysis of dynamic interactions. An extensive form is something like a flowchart for the situation we are trying to model. The extensive form describes the order in which the actors make decisions or take actions, what options they must choose from, and what they know when they must make a decision. In his section, we will see how to specify and analyze games in extensive form.

A. Defining game trees and strategies within trees.
B. Translating extensive-form games into their strategic form.
C. Nash equilibria for extensive-form games.
D. Solving perfect-information extensive-form games through backward induction.
E. Applications
F. The failure of backward induction.
G. Subgame Perfection:

Readings: Ch 11-13.

III. Repeated Games: One important aspect of social relations is the repeated interaction of the members of a group. In an industry with few buyers and sellers, buyers and sellers are likely to interact repeatedly. For example, United and American Airlines deal repeatedly with Boeing and Airbus. Members of the United States Senate must deal with each other repeatedly in their efforts to pass desired legislation. The Israelis and Palestinians deal repeatedly with each other as do the competing factions in Iraq. In its simplest form, we might try to represent a situation of repeated interaction by supposing that a group of actors play the same game repeatedly. How does this repeated interaction affect what we would expect to happen? Does repetition make for a larger or smaller set of possible outcomes? This section will provide some answers.

A. Infinitely Repeated Games.
   1. Payoffs and strategies
   2. The folk theorem for Nash equilibria.
   3. The folk theorem for subgame perfect equilibria with Nash threats.

B. Finitely Repeated Games.

Readings: Ch 15: 224-234; Ch 14; Ch 17.

IV. Asymmetric-Information Games: In all of the games discussed so far, there has been complete information. At the start of the game, each player knew everything there was to know about the other players. For example, each firm knew exactly how much it cost the other firms to increase their levels of output. Or each state in a crisis knew exactly how much risk of disaster the other state was willing to accept. But most situations we want to understand entail some "private" information. That is, a firm has private information about its production costs, or a state knows how much risk it is willing to run but the other does not. Incomplete- or asymmetric-information games provide a way of modeling situations in which there is private information, i.e., situations in which the players do not have "complete" information about each other. In this section, we will discuss some simple examples of incomplete-information games and how to analyze them.

A. Incomplete-Information Games.
B. Signaling Games
C. Perfect Bayesian Equilibria
D. The Intuitive Criterion

Readings: Ch 20: 309-18; Ch 19; Ch 24.

Tentative Schedule
(subject to change)

Aug 28:	Introduction and overview
Sep 4:	Strategic-form games
Sep 11:	Nash equilibrium
Sep 18:	Mixed-strategies Nash equilibrium
Sep 25:	Strategic-form games – applications
Oct 2:	Strategic-form games – more applications
Oct 9:	Review
Oct 16:	Midterm
Oct 23:	Extensive-form games and subgame perfection
Oct 30:	Extensive-form games -- applications
Nov 6:	Choice under risk and uncertainty
Nov 13:	Repeated games
Nov 20:	Games of social preferences
Nov 27:	Thanksgiving holiday
Dec 4:	Summary, review, and takeaways