Ph.D. in ECONOMICS

GAME THEORY (2023)

Prof. Mario Gilli

PURPOSE:

This course is an introduction to topics in game theory. Its objective is to equip the students with tools, which are essential to study the economics of information and strategic behavior and for setting up and solving a wide range of economic problems.

COURSE DESCRIPTION:

We start with game representations. First, a game tree is defined, as well as information sets and pure, mixed, and behavioral strategies, perfect recall and Kuhn's theorem, and complete as well as incomplete information. Then we consider Strategic form games and the relation among different ways of modeling Strategic Interaction. Thus, properties and calculation of solutions and Nash equilibria are discussed.
Next Nash equilibria in extensive form games are analyzed and refinements are proposed. Finally, we turn to the analysis of dynamic games with incomplete information.

STRUCTURE:

The course format is based on lectures, problem-solving and discussions, with specific stress on critical thinking. In class, I will ask many questions. I also expect you to ask many questions. In addition to these questions, I will often allow you to earn, or lose, points by verbally answering specific questions. There will be problem sets to be solved as homework.
Game theory is indeed a formal language and like all languages it should be learned by practicing, which means using it practically to solve specific examples and exercises. For this reason, the lectures will illustrate the main concepts through formal definitions and examples, with particular attention to the calculus of solutions, even if some theorems without proof will be discussed in the lectures.
Specifically, the course consists of six lectures and three classes to solve homework. In the final part of the course, the students will present in groups research papers to the class.

Groups:

You should form groups of 4-5 persons to solve homework and present research papers to the class. Effective study groups can help students learn course material in a deeper, more concrete way. Effective groups generate positive energy, encourage active participation, instill discipline, and require commitment from members. These skills are certainly important for learning.

Homework:
The homework will be quite difficult: you are not expected to be able to answer all the questions correctly. Homework is difficult because they are aimed to improve your understanding of the subtle problems of game theory.
Because of these characteristics, they are done at home and in groups so to incentivize discussions and readings among students and talks with the teacher. Clearly, this means that they are not a good forecast of the exercises for the final exam, which will be simpler.
Reviewing your answers to the problem sets and the online experiments is an integral part of the learning process, and thus of the course.

Papers' public presentations:
In the final lecture of the course, groups of students will present research papers to the class. Anyone should choose her/his group. Everyone in the group will get the same grade for the presentation. Group activities are one way of providing incentives to work and study together. The aim is to learn how to read and understand research topics, to prepare the final dissertation.

Grading:
Your course grade will be based on the homework (20%), on the group presentation (20%), and the final exam (60%). To pass the exam, you should get a sufficient mark in the final individual exam. Good class participation can improve your evaluation. I expect you to come to class prepared to respond intelligently to questions about the readings and assignments.

Textbooks:

1. Jurgen Eichberger, *Game Theory for Economists*, Academic Press,1993 = E.
2. Martin Osborne and Ariel Rubinstein, *A Course in Game Theory*, MIT Press, 1994 = OR.
3. Lecture notes.

Few comments on the books:

1. E is a basic, simple and clear book. I like it very much, unfortunately, it is very expensive (more than 100€ on amazon. it), however, there are four copies in the Bicocca library
2. OR is a complete, nice, and clear book and is freely downloadable from Rubinstein's homepage http://arielrubinstein.tau.ac.il/, unfortunately, the notation used for extensive form games is very effective but not standard

OFFICE HOURS:

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WEB SITE OF THE COURSE

Slides, information, and all you need to know can be found on the website of course:

https://elearning.unimib.it/course/view.php?id=46808

It is crucial that you register yourself at the above website

The solutions for the homework will be on the website,

- downloadable after the class and
- conditioned to the upload of a tentative solution before the class

EXAMINATION:

The examination consists of three parts: three problem sets, a group presentation, and a written individual examination. To pass the exam, you should get a sufficient mark in the final individual exam.

- **HOMEWORK**: the problem sets will consist in difficult questions that you have to solve working in a group. The marks are relative and they count for 20% of the final mark in Game Theory.
- **GROUP PRESENTATION:** the evaluation of the presentation counts for 20% of the final mark in Game Theory.
- **FINAL EXAM**: the final exam will consist of one question in one hour and it will count for 60% of the final mark in Game Theory.

DETAILED TIMETABLE OF THE LECTURES

	The topic of the lecture	Day	Chapters
L1	Models of Games - Extensive Form Games - Perfect recall and Kuhn Theorem - Strategic Form Games	31/01/2023 Demographic seminar room U7/2062 09.30 – 12.30 a.m.	E chapter 1
L2	Dominance and Rationalizability - Strict and weak dominance, simple and iterated - Bayesian rationality and rationalizability - Incomplete Information	01/02/2023 DEMS seminar room U7/2104 10.30 – 13.30 a.m.	E chapter 3
HW1	**HOMEWORK on game models and rationalizability**	01/02/2023	
L3	Nash and Bayes-Nash Equilibria - Properties and calculations in strategic and in extensive form games - Sequential rationality	08/02/2023 Demographic seminar room U7/2062 08.30 – 11.30 a.m.	E chapters 4 and 5 OR chapter 2 R section 5.3
L4	Refinements in extensive form games -1 - Weak Perfect Bayesian Equilibria - Backward Induction - Subgame Perfection - Sequential Equilibria	14/02/2023 Demographic seminar room U7/2062 08.30 – 11.30 a.m.	E chapter 6 OR chapters 6 and 12 R section 6.1
E1	**CORRECTION OF HW1**	14/02/2023 DEMS Seminar room U7/2104 02.30 – 04.30 p.m.	
HW2	**HOMEWORK 2 Nash Equilibria and extensive form refinements**	14/02/2022	

L5	Refinements in extensive form games - 2 - Forward Induction - Signalling games	15/02/2023 Demographic seminar room U7/2062 08.30 – 11.30 a.m.	E section 7.1
HW3	**HOMEWORK 3 on refinements and signaling**	15/02/2023	
E2	**CORRECTION OF HW2**	21/02/2023 Demographic seminar room U7/2062 02.30 – 04.30 p.m.	
E3	**CORRECTION OF HW3**	02/03/2023 Demographic seminar room U7/2062 10.30 – 12.30 a.m.	
L6	PRESENTATION BY GROUPS OF STUDENTS	08/03/2023 Demographic seminar room U7/2062 02.30 – 04.30 p.m.	
ME1	**MOCK EXAM**	08/03/2023 Demographic seminar room U7/2062 04.30-05.30 p.m.	
Exam		**???**	

Topics and Papers

1. **Global Games and applications:**
   a. George-Marios Angeletos, Christian Hellwig, and Alessandro Pavan, Signaling in a Global Game: Coordination and Policy Traps in *Journal of Political Economy*, Vol. 114, No. 3 (June 2006), pp. 452-484
   b. George-Marios Angeletos, Christian Hellwig, and Alessandro Pavan, Robust Predictions in Global Games with Multiple Equilibria: Defense Policies Against Currency Attacks, mimeo.
   c. George-Marios Angeletos, Alessandro Pavan, Socially Optimal Coordination: Characterization and Policy Implications, mimeo.
   d. George-Marios Angeletos, Christian Hellwig, and Alessandro Pavan, Dynamic Global Games of Regime Change: Learning, Multiplicity, and Timing of Attacks, mimeo.
   e. George-Marios Angeletos and Iván Werning, Crises and Prices: Information Aggregation, Multiplicity, and Volatility, *The American Economic Review*, Vol. 96, No. 5 (Dec., 2006), pp. 1720-1736
   f. Hans Carlsson and Eric van Damme, Global Games and Equilibrium Selection, in *Econometrica*, Vol. 61, No. 5 (Sep., 1993), pp. 989-1018
   g. Sylvain Chassang and Gerard Padr´o i Miquel, Conflict and Deterrence under Strategic Risk, *The Quarterly Journal of Economics*, November 2010
   h. David M. Frankel, Stephen Morris, and Ady Pauzner, Equilibrium selection in global games with strategic complementarities, *Journal of Economic Theory* 108 (2003) 1–44
   i. Christian Hellwig, Public Information, Private Information, and the Multiplicity of Equilibria in Coordination Games, *Journal of Economic Theory* 107, 191–222 (2002)
   j. Christian Hellwig, Arijit Mukherji and Aleh Tsyvinski, Self-Fulfilling Currency Crises: The Role of Interest Rates, in *The American Economic Review*, Vol. 96, No. 5 (Dec., 2006), pp. 1769-1787
   k. Navin Kartik, Marco Ottaviani, Francesco Squintani, Credulity, lies, and costly talk, *Journal of Economic Theory* 134 (2007) 93 – 116
   l. Stephen Morris and Hyun Song Shin, Global Games: Theory and Applications in *Advances in Economics and Econometrics*, ed. Dewatripont, Hansen and Turnovsky, Cambridge University Press 2003
   m. Stephen Morris and Hyun Song Shin, Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks, in *The American Economic Review*, Vol. 88, No. 3 (Jun., 1998), pp. 587-597
   n. Stephen Morris and Hyun Song Shin, A Theory of the Onset of Currency Attacks, mimeo
   o. Stephen Morris, Contagion, WP
   p. Stephen Morris, Hyun Song Shin, Coordination risk and the price of debt, in *European Economic Review* 48 (2004) 133 – 153
   q. Stephen Morris, Hyun Song Shin, Muhamet Yildiz, Common Belief Foundations of Global Games, WP 2015
   r. Stephen Morris and Hyun Song Shin, Rethinking Multiple Equilibria in Macroeconomic Modeling, mimeo.

2. **Bargaining:**
   a. J. C. Harsanyi and R. Selten, A Generalized Nash Solution for Two-Person Bargaining Games with Incomplete Information, *Management Science*, Vol. 18, No. 5, 1972, pp. P80-P106
   b. Roger B. Myerson Two-Person Bargaining Problems with Incomplete Information Econometrica, Vol. 52, No. 2 (Mar., 1984), pp. 461-487
   c. Martin J. Osborne and Ariel Rubinstein Bargaining and Markets 1990 by Academic Press, Inc.
   d. William Samuelson Bargaining under Asymmetric Information Econometrica, Vol. 52, No. 4 (Jul., 1984), pp. 995-1005

3. **Political Economics as Principal-Agent Models:**
   a. T. Besley, Political Selection, *The Journal of Economic Perspectives*, Vol. 19, No. 3 (Summer, 2005), pp. 43-60
   b. T. Besley and A. Case, Incumbent Behavior: Vote-Seeking, Tax-Setting, and Yardstick Competition, *The American Economic Review*, Vol. 85, No. 1 (Mar., 1995), pp. 25-45
   c. T. Besley and S. Coate, An Economic Model of Representative Democracy, *The Quarterly Journal of Economics*, Vol. 112, No. 1 (Feb., 1997), pp. 85-114
   d. T and M. Ghatak, Competition and Incentives with Motivated Agents, *The American Economic Review*, Vol. 95, No. 3 (Jun., 2005), pp. 616-636.

4. **Entry Deterrence:**
   a. Kyle Bagwell and Garey Ramey, Oligopoly limit pricing, *RAND Journal of Economics*, Vol. 22. No. 2, Summer 1991
   b. Kyle Bagwell and Garey Ramey, Capacity, entry, and forward induction, *RAND Journal of Economics*, Vol. 27, No. 4, Winter 1996, pp. 660-680
   c. Dixit, A. "The Role of Investment in Entry Deterrence", *Economic Journal*, 1980, 90, 95-106.
   d. Esther Gal-Or, First Mover Disadvantages with Private Information, *The Review of Economic Studies*, Vol. 54, No. 2 (Apr., 1987), pp. 279-292
   e. Joseph E. Harrington, Jr., Oligopolistic entry deterrence under incomplete information, *RAND Journal of Economics*, Vol. 18, No. 2. Summer 1987
   f. Paul Milgrom and John Roberts, Limit Pricing and Entry under Incomplete Information: An Equilibrium Analysis, *Econometrica*, Vol. 50, No. 2 (Mar., 1982), pp. 443-459
   g. Paul Milgrom and John Roberts, Predation, Reputation, and Entry Deterrence , *Journal of Economic Theory* 27, 280-312 (1982)
   h. M. Spence, "Entry, Capacity, Investment, and Oligopolistic Pricing", *Bell Journal of Economics*, 1977, 2, 534-544.

5. **Conflict and Strikes:**
   a. O. Ashenfelter-G. Johnson, "Bargaining Theory, Trade Unions, and Industrial Strike Activity", *American Economic Review*, 1969, 59, 35-49.
   b. P. Cramton-J. Tracy, "Strikes and Holdouts in Wage Bargaining: Theory and Data", *American Economic Review,* 1992, 82, 100-121.
   c. S. Lohmann, "A Signaling Model of Informative and Manipulative Political Action", *American Political Science Review,* 1993, 87, 319-333.

d. S. Lohmann, “Information Aggregation Through Costly Political Action”, *American Economic Review,* 1994, 84, 518-530.

6. Conflict Theory:

a. L. C. Corchón, The theory of contests: a survey, *Review Economic Design* 2007.
b. R. Cornes, R. Hartley, Asymmetric contests with general technologies, *Economic Theory* 26, 923–946, 2005.
c. J. Hirshleifer, Conflict and rent-seeking success functions: Ratio vs. difference models of relative success, *Public Choice 63:* 101-112, 1989.
d. E. Katz, S. Nitzan, I. J. Rosenberg, Rent-seeking for pure public goods, *Public Choice* 65: 49-60, 1990.
e. J. D. Perez-Castrillo, A general analysis of rent-seeking games *Public Choice* 73: 335-350, 1992.
f. K. Riaz, J. F. Shogren, S. R. Johnson, A general model of rent seeking for public goods, *Public Choice* 82: 243-259, 1995.

7. Admissibility

a. Geir B. Asheim and Martin Dufwenberg, Admissibility and common belief, *Games and Economic Behavior* 42 (2003) 208–234
b. Adam Brandenburger, Amanda Friedenberg, and Jerome Keisler, Admissibility in Games, *Econometrica*, Vol. 76, No. 2 (March, 2008), 307–352
c. Makoto Shimoji, On the equivalence of weak dominance and sequential best response, *Games and Economic Behavior* , 48 (2004) 385–402
d. Makoto Shimoji and Joel Watson, Conditional Dominance, Rationalizability, and Game Forms, *Journal of Economic Theory* 83, 161-195 (1998)
e. Chih-ChunYang, Weak assumption and iterative admissibility, *Journal of Economic Theory*, 158 (2015) 87–101

8. Herd Behavior

a. Abhijit V. Banerjee, A Simple Model of Herd Behavior, *The Quarterly Journal of Economics*, Vol. 107, No. 3 (Aug., 1992), pp. 797-817
b. Sushil Bikhchandani, David Hirshleifer and Ivo Welch, A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades, *Journal of Political Economy*, Vol. 100, No. 5 (Oct., 1992), pp. 992-1026
c. Sushil Bikhchandani, David Hirshleifer, Ivo Welch, Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades, *The Journal of Economic Perspectives*, Vol. 12, No. 3 (Summer, 1998), pp. 151-170
d. Marco Cipriani and Antonio Guarino, Herd Behavior and Contagion in Financial Markets, *The B.E. Journal of Theoretical Economics*, Volume 8, Issue 1 2008
e. Faruk Gul and Russell Lundholm, Endogenous Timing and the Clustering of Agents' Decisions, *The Journal of Political Economy*, Vol. 103, No. 5 (Oct., 1995), pp. 1039-1066
f. Klaus K. Kultti and Paavo A. Miettinen, Herding with Costly Observation, *The B.E. Journal of Theoretical Economics*, Volume 7, Issue 1 2007
g. Xavier Vives, Learning from Others: A Welfare Analysis, G*ames and Economic Behavior,* 20, 177-200 1997

9. Self Confirming Equilibria

a. Pierpaolo Battigalli, Simone Cerreia-Vioglio, Fabio Maccheroni, and Massimo Marinacci, Self-Confirming Equilibrium and Model Uncertainty, *American Economic Review* 2015, 105(2): 646–677
b. Eddie Dekel, Drew Fudenberg and David Levine, Payoff Information and Self-Confirming Equilibrium, *Journal of Economic Theory,* 89, 165-185 (1999)
c. Fudenberg, D. and D. M. Kreps, Learning in extensive games, I: self-confirming equilibrium, *Games and Economic Behavior* 8, 20-55, 1995.
d. Fudenberg, D. and D. K. Self-Confirming Equilibrium, *Econometrica*
e. 61, 523-546, 1993a.
f. Fudenberg, D. and D. K. Levine, Steady State Learning and Nash Equilibrium, *Econometrica* 61, 547-573, 1993b.
g. Ignacio Esponda, Rationalizable conjectural equilibrium: A framework for robust predictions, *Theoretical Economics* 8 (2013), 467–501
h. Drew Fudenberg and David Levine, Superstition and Rational Learning, *American Economic Review,* VOL. 96 NO. 3, June, 2006
i. Rubinstein, A. and A. Wolinsky, Rationalizable Conjectural Equilibrium: Between Nash and Rationalizability, *Games and Economic Behavior*, 6, 299-311, 1994.
j. Alvaro Sandroni and Rann Smorodinsky, Belief-based equilibrium, *Games and Economic Behavior*, 47 (2004) 157–171

10. Signaling Games

a. Jeffrey S. Banks and Joel Sobel, Equilibrium Selection in Signaling Games, *Econometrica*, Vol. 55, No. 3 (May, 1987), pp. 647-661
b. Pierpaolo Battigalli, Rationalization in Signaling Games: theory and applications, *International Game Theory Review*, Vol. 8, No. 1 (2006) 67–93
c. In-Koo Cho and David M. Kreps, Signaling Games and Stable Equilibria, *The Quarterly Journal of Economics*, Vol. 102, No. 2 (May, 1987), pp. 179-222
d. Joel Sobel, Lars Stone and Inigo Zapater, Fixed-Equilibrium Rationalizability in Signaling Games, *Journal of Economic Theory,* 52, 304-331 (1990)

11. Refinements

a. Elchanan Ben-Porath, Signaling Future Actions and the Potential for Sacrifice, *Journal of Economic Theory* 57, 36-51 (1992)
b. Tilman M. Borgers and Timothy McQuade, Information-Invariant Equilibria of Extensive Games, *The B.E. Journal of Theoretical Economics*, Volume 7, Issue 1 2007
c. In-Koo Cho, A Refinement of Sequential Equilibrium, *Econometrica*, Vol. 55, No. 6 (Nov., 1987), pp. 1367-1389
d. Jacob Glazer and Andrew Weiss, Pricing and Coordination: Strategically Stable Equilibria, *Games and Economic Behavior* 2, 118-128 (1990)
e. Faruk Gul and David Pearce, Forward Induction and Public Randomization, *Journal of Economic Theory*, 70, 43-64 (1996)
f. Elon Kohlberg and Jean-Francois Mertens, On the Strategic Stability of Equilibria, *Econometrica*, Vol. 54, No. 5 (Sep., 1986), pp. 1003-1037
g. David M. Kreps and Garey Ramey, Structural Consistency, Consistency, and Sequential Rationality, *Econometrica*, Vol. 55, No. 6 (Nov., 1987), pp. 1331-1348

h. Andrew McLennan, Justifiable Beliefs in Sequential Equilibrium, *Econometrica*, Vol. 53, No. 4 (Jul., 1985), pp. 889-904
i. Martin Osborne, Signaling, Forward Induction, and Stability in Finitely Repeated Games, *Journal of Economic Theory*, 50. 22-36 (1990)
j. Eric van Damme, Stable Equilibria and Forward Induction, *Journal of Economic Theory* 48, 476496 (1989)
k. Bingyong Zheng, Strong Forward Induction, *The B.E. Journal of Theoretical Economics,* 2017

12. Psychological Games

a. Battigalli, P. and M. Dufwenberg (2007) Guilt in Games, American Economic Review, Papers and Proceedings, 97, 170-176.
b. Battigalli, P. and M. Dufwenberg (2007) .Dynamic Psychological Games, Journal of Economic Theory 144 (2009) 1–35
c. Dufwenberg, M. (2006) .Psychological Games., entry for The New Palgrave Dictionary of Economics (2nd edition).
d. Dufwenberg, M. and G. Kirchsteiger (2004) .A Theory of Sequential Reciprocity, Games and Economic Behavior, 47, 268-298.
e. Elster, J. (1998) .Emotions and Economic Theory., Journal of Economic Literature, 36, 4774.
f. Falk, A. and U. Fischbacher (2006) A Theory of Reciprocity, Games and Economic Behavior, 54, 293-315.
g. Fehr, E. and S. Gächter (2000) Fairness and Retaliation: The Economics of Reciprocity., Journal of Economic Perspectives, 14, 159-181.
h. Geanakoplos, J., D. Pearce and E. Stacchetti (1989) .Psychological Games and Sequential Rationality., Games and Economic Behavior, 1, 60-79.
i. Kolpin, V. (1992) .Equilibrium Re.nements in Psychological Games., Games and Economic Behavior, 4, 218-231.
l. Rabin, M. (1993) .Incorporating Fairness into Game Theory and Economics, American Economic Review, 83, 1281-1302.