POLITICAL SCIENCE W4210 (FALL 2003)

RESEARCH TOPICS IN GAME THEORY

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Research topics in game theory will cover the study of repeated games, games of incomplete information and principal-agent models with applications in the fields of voting, bargaining, lobbying and violent conflict. Results from the study of social choice theory and mechanism design will also be treated. The course will concentrate on mathematical techniques for constructing and solving games. Students will be required to develop a topic relating political science and game theory and to write a formal research paper. Prerequisite: W4209 or instructor's permission.

Course Overview

Political Science W4210 is a continuation of W4209 with the objective of preparing the student to use formal models in research in political science.

- In the first two weeks of the course we state and prove results that are of very broad interest to political philosophy, public economics and positive political theory. These results are all very important in their own rights, but they will also be used to introduce key ideas about model construction to be used later on.
- In weeks 3-7, we introduce the tools you need to construct a formal model and prove results. We consider the choices that modelers need to make and the set of options that they have and we review approaches to constructing models and proving results. In these weeks we aim to provide the tools that you will need to construct a model of your own.
- In weeks 8-14 the course will take on more of a seminar format, engaging in close reading of models that use the techniques we have seen to study political problems

Requirements

The readings are typically light in terms of page numbers but are compact and heavy in notation. As one of the aims of the course is to develop skills not just in reading but in developing models, you will be expected to work through the proofs of all propositions and theorems covered in the course. Notes on close readings of these texts follow below. In addition:

1. You will be required to write an original paper presenting a model or theorem. This paper is your key output from this course, ideally it should contribute directly to the writing of your dissertation. The paper should motivate a problem, develop a model and prove ensuing propositions, and identify testable predictions resulting from the model. This research paper will account for 55% of the final grade. You may be asked to present parts of your model in class for discussion by the group. The paper is due on 13 December.
2. There will be problem sets and exercises to complete throughout the first part of the course; these are intended to evaluate your understanding of the material and to allow for deeper

exploration of models studied, and, especially, to practice model construction and proof writing. These account for 15% of the course grade and typically have to be handed in the week after they are assigned. *Late problem sets will not be accepted.*

3. In one week you will be required to review one of the central models / theorems studied in the course. For this presentation you will be expected to (i) give an overview of the question under study (ii) give a brief presentation of the proof, (iii) evaluate the model's assumptions—are all assumptions necessary? are all assumptions reasonable? (iv) discuss the solution concept employed (v) discuss the generality of field of application of the results (vi) suggest ways in which the results could be pushed further. In some weeks these presentations may be constructed in somewhat of a debate format where rival papers are discussed by different students. This presentation will account for 10% of your grade.

4. You will be required to participate in weekly sections where problem sets will be reviewed, and class and research material will be discussed. The final 20% of the grade will be based on participation in these sections.

5. All submitted writing, for your research paper or your problem sets, should be typed up on a word processor capable of handling the mathematics and symbols. It is strongly recommended, if you do not already know how, that you learn to use either Scientific Word/ Workplace (http://www.mackichan.com/index.html?products/sw.html~mainFrame) or LaTeX (http://www.latex-project.org, http://www.maths.tcd.ie/~dwilkins/LaTeXPrimer) during the course of the term and use these tools to write your papers.

Close Reading

The readings for the course are relatively few in number but you are expected to read them very very closely. The recommended approach might be what's called "anticipatory reading."

Anticipatory Reading.
1. *First read the first few pages or the conclusion, or skim through enough to find out what the general problem is.*
    1.1. Now, before going further, write down a wish list of the types of propositions / theorems that you would like to see answered in the article (*really* write down the form of the propositions as formally as you can).

2. *Read on to see what kind of results are in fact obtained.*
    2.1. Compare these with your wish list: are the results: Stronger? More general? Deeper? Surprising? Disappointing?
    2.2. Try to satisfy yourself that the results in the text are true: think of examples and try to think of counterexamples.

3. *Write down a proposed strategy of proof.*

4. *Try to prove the propositions yourself.*

    4.1. If you fail, try to prove a weaker version of the propositions.

5. *After succeeding or failing, compare your attempts with the proofs in the paper.*
    5.1. What are the advantages/disadvantages of your approach relative to the approach given in the paper? What tricks did the author use that you had not thought of?
    5.2. Is the author's proof simpler? Is it *constructive*? If the author skips some step that is not clear to you ("obviously blah blah", "blah blah is trivially true,"…) try to prove the step.
    5.3. Never try to read the proof until you understand exactly what the author is trying to prove.

Pictures and Programs

Throughout your reading: Draw pictures; Create examples; Search for counterexamples. I strongly recommend using some mathematical program (I use Matchcad) to graph the various relations (or special cases of the relations) used in the text, to see what shapes they take, how they relate to other quantities in the text, what a particular solution looks like, and so on. Mathematical programs can also be used to develop intuition about the nature of relations by searching through parameter spaces to see when given relationships do or do not hold.

Dictionary

Game theory is "notationally challenged." Even simple results often use many more signs and symbols than might have seemed necessary. When reading a text it is always useful to make your own dictionary: keep a page to one side where you record the meanings assigned to symbols in the text—pay special attention to the meaning of subscripts, superscripts and decorations. It may also be necessary for some texts to keep a mathematical dictionary handy…

Sources and Resources

Recommended Book Purchases (* strongly recommended)

- * Osborne, Martin, and Ariel Rubinstein. 1994. A Course in Game Theory. Cambridge: MIT UP. Also available on-line: http://www.netlibrary.com/ebook_info.asp?product_id=11376

- * Velleman, Daniel. 1994. How to Prove It: A Structured Approach. Cambridge: Cambridge University Press.

- Muthoo, Abhinay. 1999. Bargaining Theory with Applications. Cambridge: Cambridge University Press. Chapter 3. On reserve at the BUSINESS library.

- Grossman, Gene and Elhanan Helpman. 2001. Special Interest Politics. Cambridge: MIT University Press. On reserve at the LEHMAN library.

Other books you may need to consult in libraries

- Rasmusen, Eric. 2001. Readings in games and information. London: Blackwell. See BUSINESS: QA269 .R42 2001. On reserve at the BUSINESS library.

- Mas-Colell, Andreu, Michael Whinston, and Jerry Green. 1995. Microeconomic Theory. Oxford: Oxford University Press. See BUSINESS: HB172 .M6247 1995.

- Laver and Shepsle. 1996. Making and Breaking Governments. Cambridge: Cambridge University Press. Chapters 4 and 5. See LEHMAN Call Number: JF331 .L39 1996

Articles

- The syllabus lists many articles. The vast majority of these are available on-line and the URL is noted in the syllabus where possible. Articles that are not on line are marked with a "!". Harder articles are marked with a "**".

Recommended Books NOT on the Syllabus

- Polya, G. 1945, How to Solve It: A New Aspect of Mathematical Method. Princeton: Princeton University Press. (a useful and fairly enjoyable read)

- Myerson, Roger. 1991. Game Theory: Analysis of Conflict. Cambridge: Harvard University Press (an excellent textbook)

- Sundaram, Rangarajan. 1996. A First Course in Optimization Theory. Cambridge: Cambridge University Press. (good for technical explanations)

- Kreps, David. 1990. A Course in Microeconomic Theory, Princeton: Princeton University Press. (broad textbook written in an informal style that some love and some don't)

Recommended On-Line Resources

- Al Roth's page http://www.economics.harvard.edu/~aroth/alroth.html
- David Levine's page http://levine.sscnet.ucla.edu/
- Eric Rasmusen's page: http://php.indiana.edu/~erasmuse/GI/index.html
- e-Journals http://www.columbia.edu/cu/lweb/eresources/ejournals/
- Software for writing up game trees: http://www.cmu.edu/comlabgames/efg/index.html
- WoPEc etc.: http://netec.wustl.edu/WoPEc/   http://econwpa.wustl.edu/months/game

Topics

Part I: Some *Big Results*

Week 1   [4 SEPTEMBER] SOCIAL WELFARE, COLLECTIVE CHOICE AND EFFICIENCY

THEOREMS AND CONCEPTS: Arrow's Impossibility Theorem, the Impossibility of a Paretian Liberal and the Coase Theorem.

Readings
- Course Notes

- Sen, Amartya. 1970. "The Impossibility of a Paretian Liberal." The Journal of Political Economy, 78:1, pp. 152-57. http://www.jstor.org/view/00223808/di950932/95p0121q/0

- Coase,Ronald. 1960. "The Problem of Social Cost." Journal of Law and Economics (http://www.sfu.ca/~allen/CoaseJLE1960.pdf)

Further reading:
- Geanakoplos, John, 2001. Three Brief Proofs of Arrow's Impossibility Theorem http://cowles.econ.yale.edu/P/cd/d11a/d1123RRR.pdf
- ! Aivazian, V.A. and Jeffrey L. Callen. 1981 "The Coase Theorem and the Empty Core." Journal of Law and Economics v.24: 175 -181. See also Coase's response, same journal. *Not on-line*.

Week 2   [11 SEPTEMBER] MECHANISM DESIGN, AUCTION THEORY

THEOREMS AND CONCEPTS: The Revelation Principle, The Gibbard-Satterthwaite Theorem, the Revenue Equivalence Theorem. [If time allows: The Myerson-Satterthwaite Theorem]

Required Reading
- Osborne and Rubinstein, Chapter 10.

- Klemperer, Paul. 2000. Auction Theory: A Guide to the Literature in The Economic Theory of Auctions, Klemperer (ed.); on-line: http://www.nuff.ox.ac.uk/users/klemperer/Survey.pdf

Further Reading
- Reny, 2000. "Arrow's Theorem and the Gibbard Satterthwaite Theorem: A Unified Approach," Working Paper. http://www.src.uchicago.edu/users/preny/arrow-gibbard-satterthwaite.pdf
- *!* Myerson, Roger. B., and Satterthwaite, M. A. 1983. "Efficient mechanisms for bilateral trading." Journal of Economic Theory 28:265--281. (*Not on-line*)
- Richard D. McKelvey and Talbot Page. 2002. "Status Quo Bias in Bargaining" Journal of Economic Theory 107, 336–355. http://www.sciencedirect.com/science/journal/00220531

Part II: *Tools for Constructing and Solving Games*

Week 3   [18 SEPTEMBER*] WHAT TO PROVE I: RELEVANT PROPOSITIONS

THEOREMS AND CONCEPTS: Generality of Propositions and Strength of Assumptions, Choices (Discrete v. Continuous Action Spaces, Discrete v. Continuous Time, Atomic v. Continuous Distributions, Finite v. Infinite Horizons), Genericity and Robustness. Choices for representing preferences (Expected utility theorem, Representing attitudes to risk, Multidimensional choices).

Required Reading
- Class Notes

- Varian, Hal How to Build an Economic Model in Your Spare Time http://www.sims.berkeley.edu/%7Ehal/Papers/how.pdf

- Starmer, Chris. 2000. "Developments in Non-Expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk" Journal of Economic Literature Vol. XXXVIII 332–382 http://www.nottingham.ac.uk/~lezcs/pdf_files/STARMER_JEL.PDF

- *!* Davies, Philip et al. "The Creation of New Mathematics: An Application of the Lakatos Heuristic," Ch 44 in Rasmusen, Readings (Call Number: QA269 .R42 2001).

Further Reading
- Harry Roberts and Roman Weil, 1970. "Starting Research Early,'" University of Chicago, Graduate School of Business, http://pacioli.bus.indiana.edu/erasmuse/GI_reader/05c.roberts.htm
- Recommended to help your writing: MIT's guidelines: Writing a Math Phase Two Paper, http://www.mit.edu/afs/athena.mit.edu/course/other/mathp2/www/piil.html .
- Of historical interest: John Von Neumann and Oscar Morgenstern, 1990. Theory of Games and Economic Behavior, Princeton University Press, Chapter 3: "The Notion of Utility."

*Note: *Clash with ECPR meetings. This class may have to be held on 16 or 17 September.*

Week 4   [25 SEPTEMBER] WHAT TO PROVE II: SOLUTION CONCEPTS

THEOREMS AND CONCEPTS: Elimination of Dominated Strategies, Rationalizability, Nash Equilibrium, SPNE, Fuzzy SPNE, Refinements, Evolutionarily Stable Strategies, Stochastically Stable Equilibrium, Cooperative solutions (The Core), Zermelo's Theorem.

Required Readings
- Osborne, Martin J, and Ariel Rubinstein. 1994. A Course in Game Theory, MIT University Press, Chapters 2, 3, 4, and 13.

Further Reading for Section Debate on Cooperative v. non-cooperative game theoretic solutions.
- Diermeier, Daniel and Keith Krehbiel, 2003. "Institutionalism as a Methodology" Journal of Theoretical Politics 15**:** 2. http://ejournals.ebsco.com/Article.asp?ContributionID=4476343
- Austen-Smith, David and Jeffrey S. Banks. 1998. "Social Choice Theory, Game Theory and Positive Political Theory" in N.W. Polsby [Eds.] Annual Review of Political Science, Palo Alto: Annual Reviews. http://arjournals.annualreviews.org/doi/pdf/10.1146/annurev.polisci.1.1.259
- Aumann, Robert. 1998. "On the State of the Art in Game Theory," Games and Economic Behavior. 24: 181-210. http://sv5.vwl.tuwien.ac.at/literatur/GEB/Vol24/0612a.pdf

Further Reading:
- For more on refinements read Chapter 12 of Osborne and Rubinstein, this material will be covered in more detail in week Week 7. For more on cooperative solutions, read chapters 14.

Week 5   [2 OCTOBER] …AND HOW TO PROVE IT I: STRATEGIES OF PROOF

THEOREMS AND CONCEPTS: Direct Method of Proof, Proof by Contradiction, by Induction, Truth Tables, WLOG. Weierstrass Theorem, Intermediate Value Theorem, Fixed Point Theorems: (Brouwer, Kakutani, Borzak-Ulam, Gale-Nikaido, Hairy Ball), Existence of Nash Equilibrium.

Required Readings
- Class Notes.

- Velleman, Daniel J. 1994. How to Prove It: A Structured Approach. Cambridge: Cambridge University Press. Chapters 1-3.

- Osborne and Rubinstein, Section 2.4.

Recommended Readings:
- The rest of Velleman
- For an older political science article that uses a fixed point theorem read Herbert A. Simon's short 1954 piece: "Bandwagon and Underdog Effects and the Possibility of Election Predictions" Public Opinion Quarterly, 18:3. pp. 245-253. http://links.jstor.org/sici?sici=0033-362X%28195423%2918%3A3%3C245%3ABAUEAT%3E2.0.CO%3B2-Y
- How to Write Mathematics (from the webpages of the Mathematics Society of Trent) http://xaravve.trentu.ca/mascot/handbook/SEC_write.pdf
- For more on the mathematical results see the appendices in Mas-Colell, Whinston, and Green or in Rasmusen's Games and Information, or in topology texts such as Berge's, Topological Spaces.

Week 6 [9 OCTOBER] …AND HOW TO PROVE IT II: TOOLS FOR REPEATED GAMES

CONCEPTS AND THEOREMS: The One Stage Deviation Principle, The Bellman Equation, Existence and Uniqueness of Equilibrium in Stahl-Rubinstein Game, Folk-theoretic results

Required Readings:
- Class Notes

- Muthoo, Abhinay. 1999. Bargaining Theory with Applications, Cambridge: Cambridge University Press. 3.1-.2.

- Osborne and Rubinstein, Sections 8.1-5.

- *!* Ferejohn, John. 1986. "Incumbent Performance and Electoral Control" Public Choice 50: 5-26 *or* Chapter 1 in Perrson and Tabellini. 1995. Monetary and Fiscal Policy 2: Politics, Cambridge, MIT University Press.

Recommended Readings:
- For a more general presentation of the Rubinstein model, see Osborne and Rubinstein, Sections 7.2-3 or the rest of Muthoo Chapter 3
- For a richer but tougher model than Ferejohn's try: Jeffrey S. Banks and Rangarajan Sundaram. "Adverse Selection and Moral Hazard in a Repeated Elections Model," in Political Economy: Institutions, Information, Competition, and Representation, (W. Barnett, et al, Eds.), Cambridge University Press, Cambridge and New York, 1993.
- A recent application of folk theoretic ideas to the study of ethnic politics is found in Fearon, James D. and David D. Laitin. 1996. "Explaining Interethnic Cooperation," APSR, 90:715-735. http://links.jstor.org/sici?sici=0003-0554%28199612%2990%3A4%3C715%3AEIC%3E2.0.CO%3B2-8

! DUE! :   ***** HAND IN MODEL OUTLINE *****

Week 7 [16 OCTOBER] …AHTPI III: TOOLS FOR GAMES OF UNCERTAINTY

CONCEPTS AND THEOREMS: Using Bayes' Rule, using equilibrium refinements, Perfect Bayesian Equilibria, Sequential equilibrium, Signaling and Screening, The Single-Crossing Property.

Required Readings:
- Class Notes

- Nalebuff, Nalebuff (1991), "Rational Deterrence in an Imperfect World" World Politics, 43:3, pp. 313-335.

- Mas-Colell, Andreu, Michael Whinston, and Jerry Green, 1995. Microeconomic Theory. Oxford, Oxford University Press. See BUSINESS: HB172 .M6247 1995. Chapter 13

Further Reading
- Osborne and Rubinstein, Chapter 12.
- To see some of the refinements "in action" see Banks, Jeffrey, Colin Camerer, and David Porter, David., 1996. "An Experimental Analysis of Nash Refinements in Signaling Games," Games and Economic Behavior. 6: 1-31.

Part III: *Game Theory Applied to Politics*

Week 8   [23 OCTOBER] VOTING

Required Readings:
- ** Plott, Charles R. 1967. "A Notion of Equilibrium and Its Possibility Under Majority Rule." American Economic Review 57 (4): 787-806. http://links.jstor.org/sici?sici=0002-8282%28196709%2957%3A4%3C787%3AANOEAI%3E2.0.CO%3B2-N

- ** McKelvey, Richard and Norman Schofield. 1987. "Generalized Symmetry Conditions at a Core Point." Econometrica 55: 923-933. http://links.jstor.org/sici?sici=0012-9682%28198707%2955%3A4%3C923%3AGSCAAC%3E2.0.CO%3B2-P

- Tsebelis, George. 1995. Decision Making in Political Systems: Veto Players in Presidentialism, Parliamentarism, Multicameralism and Multipartyism. BJPS. 25: 3. pp. 289-325. http://links.jstor.org/sici?sici=0007-1234%28199507%2925%3A3%3C289%3ADMIPSV%3E2.0.CO%3B2-J

Further Reading
- For some of the very pessimistic implications of this work see: McKelvey, R.D. 1976. Intransitivities in multidimensional voting models and some implications for agenda control. Journal of Economic Theory, 12:472-82.
- For more positive results see: Sen, Amartya and P.K. Pattanaik. 1982. Choice Welfare and Measurement. Cambridge: Harvard University Press. Chapter 7: "Necessary and Sufficient Conditions for Rational Choice under Majority Decision."

Week 9   [30 OCTOBER] INSTITUTIONS

Required Readings:
- Kenneth Shepsle, "Institutional Arrangements and Equilibrium in Multidimensional Voting Models," AJPS 23 (February 1979): 27-59. http://links.jstor.org/sici?sici=0092-5853%28197902%2923%3A1%3C27%3AIAAEIM%3E2.0.CO%3B2-X

- *!* Laver and Shepsle. 1996. Making and Breaking Governments. Cambridge: Cambridge University Press. Chapters 4 and 5. *Not on-line.* See LEHMAN Call Number: JF331 .L39 1996

Further Reading
- *!* Persson, Torsten and Guido Tabellini. 2000. Political Economics: Explaining Economic Policy. MIT Press. Chapters 3, 8 and 9.
- Timothy Besley and Stephen Coate, 1997, "An economic model of representative democracy," Quarterly Journal of Economics 112: 85-114. http://links.jstor.org/sici?sici=0033-5533%28199702%29112%3A1%3C85%3AAEMORD%3E2.0.CO%3B2-X
- *!* John Roemer, 2001. Political Competition Cambridge, Harvard University Press.

Week 10   [6 NOVEMBER] BARGAINING

Required Reading
- Muthoo, Abhinay. 1999. Bargaining Theory with Applications, Cambridge University Press. Chapters 2, 4 and 9.

- Tim Groseclose; Nolan McCarty The Politics of Blame: Bargaining before an Audience American Journal of Political Science, Vol. 45, No. 1. (Jan., 2001), pp. 100-119. http://links.jstor.org/sici?sici=0092-5853%28200101%2945%3A1%3C100%3ATPOBBB%3E2.0.CO%3B2-0

Further Reading for Section Debate on Bargaining Sets:
Read: Dai**,** Xinyuan. 2002. "Political regimes and international trade: the democratic difference revisited," American Political Science Review 96 (1), 159-165 and response by Mansfield et al. (For background you may also need to read E. Mansfield, H. Milner, and B. P. Rosendorff. Free to Trade: Democracies, Autocracies and International Trade, American Political Science Review **94** (2000), 305–22.) http://www.columbia.edu/cgi-bin/cul/resolve?AUX2407.001

Further Reading
- David Baron and John Ferejohn. 1989. "Bargaining in Legislatures," APSR 83: 1181-1206. http://links.jstor.org/sici?sici=0003-0554%28198912%2983%3A4%3C1181%3ABIL%3E2.0.CO%3B2-N
- Banks, Jeffrey and John Duggan. 2000. "A Bargaining Model of Collective Choice." American Political Science Review 94: 73–88. http://www.columbia.edu/cgi-bin/cul/resolve?AUX2407.001

Week 11   [13 NOVEMBER] LOBBYING

Required Readings:
- Gene Grossman and Elhanan Helpman. Special Interest Politics. Cambridge: MIT University Press. Chapters 7 and 8.

- Austen-Smith, David. 1993. Information and Influence: Lobbying for Agendas and Votes American Journal of Political Science, 37:3, pp. 799-833. http://links.jstor.org/sici?sici=0092-5853%28199308%2937%3A3%3C799%3AIAILFA%3E2.0.CO%3B2-0

Recommended Reading
- William Mitchell and Michael Munger. 1991. "Economic Models of Interest Groups: An Introductory Survey," AJPS 35: 512-546. http://links.jstor.org/sici?sici=0092-5853%28199105%2935%3A2%3C512%3AEMOIGA%3E2.0.CO%3B2-L
- Dixit, Avinash, Gene Grossman, and Elhanan Helpman. 1997. "Common agency and coordination: General theory and application to government policymaking," Journal of Political Economy. 105(4), 752-769. http://links.jstor.org/sici?sici=0022-3808%28199708%29105%3A4%3C752%3ACAACGT%3E2.0.CO%3B2-Q
- Gary S. Becker, "A Theory of Competition among Pressure Groups for Political Influence," Quarterly Journal of Economics (August 1983): 371-400. http://links.jstor.org/sici?sici=0033-5533%28198308%2998%3A3%3C371%3AATOCAP%3E2.0.CO%3B2-I

Week 12   [20 NOVEMBER] VIOLENCE

Required Readings:
- Hirshleifer, Jack. 1995. "Theorizing about Conflict." in <u>Handbook of Defense Economics</u>, ed. Hartley, K. and Todd Sandler, 165-89. Vol.1, Amsterdam, Elsevier Science. In Library. See also: http://www.econ.ucla.edu/workingpapers/wp727.pdf

- Bates, Robert H., Avner Greif, and Smita Singh. 2002. "<u>Organizing Violence</u>." <u>Journal of Conflict Resolution</u> 46:5. http://www.columbia.edu/cgi-bin/cul/resolve?clio3326743.004

- Konrad, K.A. and S. Skaperdas. 1998. "Extortion." <u>Economica</u> 65 : 461-477. http://www.columbia.edu/cgi-bin/cul/resolve?clio3325772.001

Recommended Reading
- Grossman, Herschel. I. 1991. "A General Equilibrium Model of Insurrections." <u>American Economic Review</u>. 81, pp. 912-21. http://links.jstor.org/sici?sici=0002-8282%28199109%2981%3A4%3C912%3AAGEMOI%3E2.0.CO%3B2-F

Week 13   [27 NOVEMBER] NO CLASSES (THANKSGIVING)

Week 14   [3 DECEMBER] NEW DIRECTIONS

Required Readings: Some of… (yet to be determined)

- H. Peyton Young. 1998. <u>Individual Strategy and Social Structure: An Evolutionary Theory of Institutions</u>. Princeton: Princeton University Press.

- Brian Skyrms, 1996. <u>Evolution of the Social Contract</u>. Cambridge: Cambridge University Press.

- Samuelson, Larry. 1998. <u>Evolutionary Games and Equilibrium Selection</u> Cambridge: MIT Press.

- Camerer, Colin: <u>Behavioral Game Theory: Experiments in Strategic Interaction.</u> Princeton University Press.

- Epstein, Joshua, John D. Steinbruner, and Miles T. Parker, 2001. "Modeling Civil Violence: An Agent-Based Computational Approach," Brookings Institution CSED Working Paper 20. URL http://www.brook.edu/es/dynamics/papers/cviolence/cviolence.htm

- Rubinstein, Ariel. 1998. <u>Modeling Bounded Rationality</u> Cambridge, MIT Press.