

games and ^{4E}
information



games and ^{4E} *information*

An Introduction to Game Theory

eric rasmusen



 **Blackwell**
Publishing

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BLACKWELL PUBLISHING
350 Main Street, Malden, MA 02148-5020, USA
9600 Garsington Road, Oxford OX4 2DQ, UK
550 Swanston Street, Carlton, Victoria 3053, Australia

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First published 1989
Second edition published 1994
Third edition published 2001
Fourth edition published 2007 by Blackwell Publishing Ltd

1 2007

Library of Congress Cataloging-in-Publication Data

Rasmusen, Eric.

Games and information : an introduction to game theory / Eric Rasmusen. – 4th ed.
p. cm.

Includes bibliographical references and index.

ISBN-13: 978-1-4051-3666-2 (hardback)

ISBN-10: 1-4051-3666-9 (hardback)

1. Game theory. I. Title

QA269.R37 2007

519.3—dc22

2006029009

A catalogue record for this title is available from the British Library.

Set in 10/12 pt Times
by Newgen Imaging Systems (P) Ltd., Chennai, India
Printed and bound in the United Kingdom
by TJ International Ltd, Padstow, Cornwall

The publisher's policy is to use permanent paper from mills that operate a sustainable forestry policy, and which has been manufactured from pulp processed using acid-free and elementary chlorine-free practices. Furthermore, the publisher ensures that the text paper and cover board used have met acceptable environmental accreditation standards.

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Blackwell Publishing, visit our website:
www.blackwellpublishing.com

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*Sections that are starred are less important

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preface

Contents and Purpose

This book is about noncooperative game theory and asymmetric information. In the introduction, I will say why I think these subjects are important, but here in the preface I will try to help you decide whether this is the appropriate book to read if they do interest you.

I write as an applied theoretical economist, not as a game theorist, and readers in anthropology, law, physics, accounting, and management science have helped me to be aware of the provincialisms of economics and game theory. My aim is to present the game theory and information economics that currently exist in journal articles and oral tradition in a way that shows how to build simple models using a standard format. Journal articles are more complicated and less clear than seems necessary in retrospect; precisely because it is original, even the discoverer rarely understands a truly novel idea. After a few dozen successor articles have appeared, we all understand it and marvel at its simplicity. But journal editors are unreceptive to new articles that admit to containing exactly the same idea as old articles, just presented more clearly. At best, the clarification is hidden in some new article's introduction or condensed to a paragraph in a survey. Students, who find every idea as complex as the originators of the ideas did when they were new, must learn either from the confused original articles or the oral tradition of a top economics department. This book tries to help.

Changes in the Second Edition, 1994

By now, just a few years later after the First Edition, those trying to learn game theory have more to help them than just this book, and I will list a number of excellent books below. I have also thoroughly revised *Games and Information*. George Stigler used to say that it was a great pity Alfred Marshall spent so much time on the eight editions of *Principles of Economics* that appeared between 1890 and 1920, given the opportunity cost of

the other books he might have written. I am no Marshall, so I have been willing to sacrifice a Rasmusen article or two for this new edition, though I doubt I will keep it up till 2019.

What I have done for the Second Edition is to add a number of new topics, increase the number of exercises (and provide detailed answers), update the references, change the terminology here and there, and rework the entire book for clarity. A book, like a poem, is never finished, only abandoned (which is itself a good example of a fundamental economic principle). The one section I have dropped is the somewhat obtrusive discussion of existence theorems; I recommend Fudenberg & Tirole (1991a) on that subject. The new topics include auditing games, nuisance suits, recoordination in equilibria, renegotiation in contracts, supermodularity, signal jamming, market microstructure, and government procurement. The discussion of moral hazard has been reorganized. The total number of chapters has increased by two, the topics of repeated games and entry having been given their own chapters.

Changes in the Third Edition, 2001

Besides numerous minor changes in wording, I have added new material and reorganized some sections of the book.

The new topics are 10.3 “Price Discrimination”; 12.6 “Setting up a Way to Bargain: The Myerson–Satterthwaite Mechanism”; 13.3 “Risk and Uncertainty over Values” (for private-value auctions); A.7 “Fixed-Point Theorems”; and A.8 “Genericity.”

To accommodate the additions, I have dropped 9.5 “Other Equilibrium Concepts: Wilson Equilibrium and Reactive Equilibrium” (which is still available on the book’s website), and Appendix A, “Answers to Odd-Numbered Problems.” These answers are very important, but I have moved them to the website because most readers who care to look at them will have web access and problem answers are peculiarly in need of updating. Ideally, I would like to discuss all likely wrong answers as well as the right answers, but I learn the wrong answers only slowly, with the help of new generations of students.

Chapter 10, “Mechanism Design in Adverse Selection and in Moral Hazard with Hidden Information,” is new. It includes two sections from chapter 8 (8.1 “Pooling versus Separating Equilibrium and the Revelation Principle” is now section 10.1; 8.2 “An Example of Moral Hazard with Hidden Knowledge: the Salesman Game” is now section 10.2) and one from chapter 9 (9.6 “The Groves Mechanism” is now section 10.5).

Chapter 15 “The New Industrial Organization,” has been eliminated and its sections reallocated. Section 15.1 “Why Established Firms Pay Less for Capital: The Diamond Model” is now section 6.6; section 15.2 “Takeovers and Greenmail” remains section 15.2; section 15.3 “Market Microstructure and the Kyle Model” is now section 9.5; and section 15.4 “Rate-of-return Regulation and Government Procurement” is now section 10.4.

Topics that have been extensively reorganized or rewritten include 14.2 “Prices as Strategies”; 14.3 “Location Models”; the Mathematical Appendix, and the Bibliography. Section 4.5 “Discounting” is now in the Mathematical Appendix; 4.6 “Evolutionary Equilibrium: The Hawk–Dove Game” is now section 5.6; 7.5 “State-space Diagrams: Insurance Games I and II” is now section 8.5 and the sections in chapter 8 are reordered; 14.2 “Signal Jamming: Limit Pricing” is now section 11.6. I have recast 1.1 “Definitions,” taking out the OPEC Game and using an entry deterrence game instead, to illustrate the difference

between game theory and decision theory. Every other chapter has also been revised in minor ways.

Some readers preferred the First Edition to the Second because they thought the extra topics in the Second Edition made it more difficult to cover. To help with this problem, I have now starred the sections that I think are skippable. For reference, I continue to have those sections close to where the subjects are introduced.

The two most novel features of the book are not contained within its covers. One is the website, at <http://rasmusen.org/GI/index.html>

The website includes answers to the odd-numbered problems, new questions and answers, errata, files from my own teaching suitable for making overheads, and anything else I think might be useful to readers of this book.

The second new feature is a reader, *Rasmusen (2001)* – a prettified version of the course packet I use when I teach this material. This is available from Blackwell Publishing, and contains scholarly articles, news clippings, and cartoons arranged to correspond with the chapters of the book. I have tried especially to include material that is somewhat obscure or hard to locate, rather than just a collection of classic articles from leading journals.

If there is a fourth edition, three things I might add are (1) a long discussion of strategic complements and substitutes in chapter 14, or perhaps even as a separate chapter; (2) Holmstrom & Milgrom's 1987 article on linear contracts; and (3) Holmstrom & Milgrom's 1991 article on multitask agency. Readers who agree, let me know and perhaps I'll post notes on these topics on the website.

Changes in the Fourth Edition, 2006

Games and Information continues to do well despite the continued flow of books on game theory and industrial organization, and the arrival of a number of specialized books on topics such as contracting and auctions. I've had emails from readers in Canada, Chile, China, Dubai, Germany, Great Britain, India, Iran, Italy, Jamaica, Korea, Malaysia, Man, Mexico, Norway, Paraguay, Portugal, Spain, Taiwan, and the United States. This encourages me to think a new edition would be worthwhile, incorporating, especially, new models and ways to organize thoughts for the the material on asymmetric information in the second half of the book. I have also added more homework problems, and fourteen classroom games, one at the end of each chapter. Besides the specific changes mentioned below, I have made minor changes throughout the book.

The chapters that have been most changed are chapters 10 (Mechanisms), 13 (Auctions), and 14 (Pricing), but there is also new material in other chapters. Chapter 3 (Mixed Strategies) now has material on Bertrand equilibrium and strategic substitutes and complements formerly in chapter 14 and material on patent races formerly in chapter 15. It has a new section on existence of equilibrium, and an example of how a pure strategy can be strictly dominated by a mixed strategy.

Chapter 7 (Moral Hazard I) has a discussion of quasilinear utility functions and the effect of changes in bargaining power.

Chapter 8 (Moral Hazard II) has a new section on Holmstrom & Milgrom's 1991 idea of multitask agency, in which the agent uses more than one kind of effort and generates multiple outputs, only one of which can be well measured.

Chapter 9 (Adverse Selection) has a new version of the Production Game to illustrate the combination of moral hazard with adverse selection.

Chapter 10 (Mechanisms) also has a new version of the Production Game, used to illustrate mechanism design and the new topic of cross checking. I have added a section on the Sender–Receiver game of Crawford and Sobel. I’ve cut back on the treatment of Myerson’s Trading Game, giving just one version instead of three. In general, I have tried to make the notation and analysis of this chapter more uniform, putting special emphasis on the standard outcome that the bad type’s participation constraint and the good type’s incentive compatibility constraints are binding. I have moved away from the term “moral hazard with hidden knowledge” in favor of the more direct “post-contractual hidden knowledge.”

Chapter 11 (Signalling) contains the new topic of countersignalling (introduced in Feltovich, Harbaugh, & To [2002]), under which middle-quality types signal, but the best types deliberately do not, instead relying on other means of conveying their type. I have also replaced the 3rd edition’s model of limit pricing as signal jamming with a new, simpler model.

Chapter 13 (Auctions) is the most drastically changed, by far. In earlier editions the treatment of auctions was relatively nontechnical because I wished to avoid the difficult task of trying to convey that intricate but unified literature in the simplified style of the rest of the book. By now, however, enough new treatments of the old material has appeared for the unities in auction theory to be presented more simply, and so I’ve made the chapter much longer, and technical. This allows me to add topics such as all-pay auctions, proof of the Revenue Equivalence Theorem, the marginal-revenue interpretation of reserve prices, a formal model comparing different auction rules in a common-value auction, Klemperer’s Wallet Game, affiliation, and linkage.

Chapter 14 (Pricing) has a section on vertical quality differentiation, by a monopolist and by a duopoly, which also allows discussion of “crimping the product.”

I have dropped Chapter 15 (Entry), though it remains available at the website. Its topics had no technical unity, and while they served well as examples of techniques from earlier chapters, I decided that they contained enough examples, especially as new editions have been increasing the number of models in those earlier chapters.

The book’s website is at <http://rasmusen.org/GI>.

The answers to the odd-numbered homework problems, and teaching notes for the classroom games are at <http://rasmusen.org/GI/funstuff.htm>.

The classroom games are an innovation with this edition. I have found it helpful in MBA and undergraduate classes to have students take the parts of players in games. The greatest benefit is to force them to think about possible strategies and to realize that models are imperfect descriptions of the real world even in the controlled situation of a classroom – but that they do provide a starting point for thinking about the real world. Most of the games are less useful at teaching actual results because of the many outcomes that can happen, but they are useful as something like case studies, particular histories on which students and teacher can comment. Whether the games are useful for PhD students is less clear, but they, too, need to understand the link between models and reality, something hard to convey in lectures.

I am very interested in hearing feedback on how the classroom games work in particular situations. I have included detailed instructions on practical matters (e.g., what overheads to

bring to class, what instructions the players are likely to get wrong), but I am sure I will hear of improvements in both implementation and explanation. I have included one game for each chapter, but some topics lend themselves to games more than others – mixed strategies, public good dilemmas, and backwards induction, in particular, with contracting being the least suited to games.

Readings in Games and Information continues to be available in hardback and paperback from Blackwell Publishing. Its website is at <http://rasmusen.org/GI/reader/rcontents.htm>.

Using the Book

The book is divided into three parts: part I on game theory; part II on information economics; and part III on applications to particular subjects. Parts I and II, but not part III, are ordered sets of chapters.

Part I by itself would be appropriate for a course on game theory, and sections from part III could be added for illustration. If students are already familiar with basic game theory, part II can be used for a course on information economics. The entire book would be useful as a secondary text for a course on industrial organization. I teach material from every chapter in a semester-long course for first- and second-year doctoral students at Indiana University's Kelley School of Business, including more or fewer chapter sections depending on the progress of the class.

Exercises and notes follow the chapters. It is useful to supplement a book like this with original articles, but I leave it to my readers or their instructors to follow up on the topics that interest them rather than recommending particular readings. I also recommend that readers try attending a seminar presentation of current research on some topic from the book; while most of the seminar may be incomprehensible, there is a real thrill in hearing someone attack the speaker with "Are you sure that equilibrium is perfect?" after just learning the previous week what "perfect" means.

Some of the exercises at the end of each chapter put slight twists on concepts in the text while others introduce new concepts. Answers to odd-numbered questions are given at the website. I particularly recommend working through the problems for those trying to learn this material without an instructor.

The endnotes to each chapter include substantive material as well as recommendations for further reading. Unlike the notes in many books, they are not meant to be skipped, since many of them are important but tangential, and some qualify statements in the main text. Less important notes supply additional examples or list technical results for reference. A mathematical appendix at the end of the book supplies technical references, defines certain mathematical terms, and lists some items for reference even though they are not used in the main text.

The Level of Mathematics

In surveying the prefaces of previous books on game theory, I see that advising readers how much mathematical background they need exposes an author to charges of being out

of touch with reality. The mathematical level here is about the same as in Luce & Raiffa (1957), and I can do no better than to quote the advice on page 8 of their book:

Probably the most important prerequisite is that ill-defined quality: mathematical sophistication. We hope that this is an ingredient not required in large measure, but that it is needed to some degree there can be no doubt. The reader must be able to accept conditional statements, even though he feels the suppositions to be false; he must be willing to make concessions to mathematical simplicity; he must be patient enough to follow along with the peculiar kind of construction that mathematics is; and, above all, he must have sympathy with the method – a sympathy based upon his knowledge of its past successes in various of the empirical sciences and upon his realization of the necessity for rigorous deduction in science as we know it.

If you do not know the terms “risk-averse,” “first order condition,” “utility function,” “probability density,” and “discount rate,” you will not fully understand this book. Flipping through it, however, you will see that the equation density is much lower than in first-year graduate microeconomics texts. In a sense, game theory is less abstract than price theory, because it deals with individual agents rather than aggregate markets and it is oriented towards explaining stylized facts rather than supplying econometric specifications. Mathematics is nonetheless essential. Professor Wei puts this well in his informal unpublished class notes:

My experience in learning and teaching convinces me that going through a proof (which does not require much mathematics) is *the most effective way in learning, developing intuition, sharpening technical writing ability, and improving creativity*. However it is an extremely painful experience for people with simple mind and narrow interests.

Remember that a good proof should be *smooth* in the sense that any serious reader can read through it like the way we read *Miami Herald*; should be *precise* such that no one can add/delete/change a word – like the way we enjoy Robert Frost’s poetry!

I wouldn’t change a word of that.

Other Books

At the time of the first edition of this book, most of the topics covered were absent from existing books on either game theory or information economics. Noteworthy older books on game theory include Luce & Raiffa (1957), Moulin (1986), Ordeshook (1986), Rapoport (1960, 1970), and Shubik (1982). Books on information in economics were mainly concerned with decision making under uncertainty rather than asymmetric information. Since the First Edition, a spate of books on game theory has appeared. The stream of new books has become a flood, and one of the pleasing features of this literature is its variety. Each one is different, and both student and teacher can profit by owning an assortment of them, something one cannot say of many other subject areas. We have not converged, perhaps because teachers are still converting into books their own independent materials from courses not taught with texts. I only wish I could say I had been able to use all my competitors’ good ideas in the present edition.

Why, you might ask in the spirit of game theory, do I conveniently list all my competitor’s books here, giving free publicity to books that could substitute for mine? For an answer, you must buy this book and read chapter 11 on signalling. Then you will understand that

only an author quite confident that his book compares well with possible substitutes would do such a thing, and you will be even more certain that your decision to buy the book was a good one.

Some Books on Game Theory and Its Applications

- 1988** **Tirole**, Jean, *The Theory of Industrial Organization*. MIT Press. 479 pages. Still the standard text for advanced industrial organization.
- 1989** **Eatwell**, John, Murray Milgate, & Peter Newman, eds., *The New Palgrave: Game Theory*. Norton. 264 pages. A collection of brief articles on topics in game theory by prominent scholars.
- Rasmusen**, Eric, *Games and Information*, 1st edition. Blackwell Publishing. 352 pages.
- Schmalensee**, Richard & Robert Willig, eds., *The Handbook of Industrial Organization*, in two volumes. North-Holland. A collection of not-so-brief articles on topics in industrial organization by prominent scholars.
- Spulber**, Daniel *Regulation and Markets*. MIT Press. 690 pages. Applications of game theory to rate of return regulation.
- 1990** **Banks**, Jeffrey, *Signalling Games in Political Science*. Harwood Publishers. 90 pages. Out of date by now, but worth reading anyway.
- Friedman**, James, *Game Theory with Applications to Economics*, 2nd edition. Oxford University Press (1st edition, 1986). 322 pages. By a leading expert on repeated games.
- Kreps**, David, *A Course in Microeconomic Theory*. Princeton University Press. 850 pages. A competitor to Varian's PhD micro text, in a more conversational style, albeit a conversation with a brilliant economist at a level of detail that scares some students.
- Kreps**, David, *Game Theory and Economic Modeling*. Oxford University Press. 195 pages. A discussion of Nash equilibrium and its problems.
- Krouse**, Clement, *Theory of Industrial Economics*. Blackwell Publishing. 602 pages. A good book on the same topics as Tirole's 1988 book, largely overshadowed by it.
- 1991** **Dixit**, Avinash K. & Barry J. Nalebuff, *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life*. Norton. 393 pages. A book in the tradition of popular science, full of fun examples but with serious ideas too. I use this for my MBA students' half-semester course, though newer books are offering competition for that niche.
- Fudenberg**, Drew & Jean Tirole, *Game Theory*. MIT Press. 579 pages. This has become the standard text for second-year PhD courses in game theory. (Though I hope the students are referring back to *Games and Information* for help in getting through the hard parts.)
- Milgrom**, Paul and John Roberts, *Economics of Organization and Management*. Prentice-Hall. 621 pages. A model for how to think about organization and management. The authors taught an MBA course from this, but I wonder whether that is feasible anywhere but Stanford Business School.
- Myerson**, Roger, *Game Theory: Analysis of Conflict*. Harvard University Press. 568 pages. At an advanced level. In revising for the third edition, I noticed how well

Myerson's articles are standing the test of time. There's even more Myerson in the fourth edition.

- 1992** **Aumann**, Robert & Sergiu Hart, eds., *Handbook of Game Theory with Economic Applications*, Volume 1. North-Holland. 733 pages. A collection of articles by prominent scholars on topics in game theory.
- Binmore**, Ken, *Fun and Games: A Text on Game Theory*. D.C. Heath. 642 pages. No pain, no gain; but pain and pleasure can be mixed even in the study of mathematics.
- Gibbons**, Robert, *Game Theory for Applied Economists*. Princeton University Press. 267 pages. Perhaps the main competitor to *Games and Information*. Shorter and less idiosyncratic.
- Hirshleifer**, Jack & John Riley, *The Economics of Uncertainty and Information*. Cambridge University Press. 465 pages. An underappreciated book that emphasizes information rather than game theory.
- McMillan**, John, *Games, Strategies, and Managers: How Managers Can Use Game Theory to Make Better Business Decisions*. Oxford University Press. 252 pages. Largely verbal, very well written, and an example of how clear thinking and clear writing go together.
- Varian**, Hal, *Microeconomic Analysis*, 3rd edition. Norton (1st edition, 1978; 2nd edition, 1984) 547 pages. Varian was the standard PhD micro text when I took the course in 1980. The third edition is much bigger, with lots of game theory and information economics concisely presented.
- 1993** **Basu**, Kaushik, *Lectures in Industrial Organization Theory*. Blackwell Publishing. 236 pages. Lots of game theory as well as I.O.
- Laffont**, Jean-Jacques & Jean Tirole, *A Theory of Incentives in Procurement and Regulation*. MIT Press. 705 pages. If you like section 10.6 of *Games and Information*, here is an entire book on the model.
- Martin**, Stephen, *Advanced Industrial Economics*. Blackwell Publishing. 660 pages. Detailed and original analysis of particular models, and much more attention to empirical articles than Krouse, Shy, and Tirole.
- 1994** **Aumann**, Robert & Sergiu Hart, eds., *Handbook of Game Theory with Economic Applications*, Volume 2. North-Holland. A collection of articles by prominent scholars on topics in game theory.
- Baird**, Douglas, Robert Gertner & Randal Picker, *Strategic Behavior and the Law: The Role of Game Theory and Information Economics in Legal Analysis*. Harvard University Press. 330 pages. A mostly verbal but not easy exposition of game theory using topics such as contracts, procedure, and tort.
- Gardner**, Roy, *Games for Business and Economics*. John Wiley and Sons. 480 pages. Indiana University has produced not one but two game theory texts.
- Morris**, Peter, *Introduction to Game Theory*. Springer-Verlag. 230 pages. Not in my library yet.
- Morrow**, James, *Game Theory for Political Scientists*. Princeton University Press. 376 pages. The usual topics, but with a political science slant, and especially good on things such as utility theory.
- Osborne**, Martin & Ariel Rubinstein, *A Course in Game Theory*. MIT Press. 352 pages. Similar in style to Eichberger's 1993 book. See their excellent "List of

- Results” on pages 313-19 which summarizes the mathematical propositions without using specialized notation.
- Rasmusen**, Eric, *Games and Information*, 2nd edition. Blackwell Publishing.
- 1995 Mas-Colell**, Andreu, Michael D. Whinston, & Jerry R. Green, *Microeconomic Theory*. Oxford University Press. 981 pages. This combines the topics of Varian’s PhD micro text, those of *Games and Information*, and general equilibrium. Massive, and a good reference.
- Owen**, Guillermo, *Game Theory*. Academic Press, 3rd edition (1st edition, 1968; 2nd edition, 1982) This book clearly lays out the older approach to game theory, and holds the record for longevity in game theory books.
- 1996 Besanko**, David, David Dranove, & Mark Shanley, *Economics of Strategy*. John Wiley and Sons. This actually can be used with Indiana M.B.A. students, and clearly explains some very tricky ideas such as strategic complements.
- Shy**, Oz, *Industrial Organization, Theory and Applications*. MIT Press. 466 pages. A new, somewhat easier competitor to Tirole’s 1988 book.
- 1997 Gates**, Scott & Brian Humes, *Games, Information, and Politics: Applying Game Theoretic Models to Political Science*. University of Michigan Press. 182 pages.
- Ghemawat**, Pankaj, *Games Businesses Play: Cases and Models*. MIT Press. 255 pages. Analysis of six cases from business using game theory at the MBA level. Good for the difficult task of combining theory with evidence.
- Macho-Stadler**, Ines, & J. David Perez-Castillo, *An Introduction to the Economics of Information: Incentives and Contracts*. Oxford University Press. 277 pages. Entirely on moral hazard, adverse selection, and signalling.
- Romp**, Graham, *Game Theory: Introduction and Applications*. Oxford University Press. 284 pages. With unusual applications (chapters on macroeconomics, trade policy, and environmental economics) and lots of exercises with answers.
- Salanie**, Bernard, *The Economics of Contracts: A Primer*. MIT Press. 232 pages. Specialized to a subject of growing importance.
- 1998 Bierman**, H. Scott & Luis Fernandez, *Game Theory with Economic Applications*. Addison Wesley, 2nd edition (1st edition, 1993) 452 pages. A text for undergraduate courses, full of good examples.
- Dugatkin**, Lee & Hudson Reeve, ed., *Game Theory & Animal Behavior*. Oxford University Press. 320 pages. Just on biology applications.
- 1999 Aliprantis**, Charalambos & Subir Chakrabarti, *Games and Decisionmaking*. Oxford University Press. 224 pages. An undergraduate text for game theory, decision theory, auctions, and bargaining, the third game theory text to come out of Indiana.
- Basar**, Tamar & Geert Olsder, *Dynamic Noncooperative Game Theory*, 2nd edition, revised. Society for Industrial and Applied Mathematics (1st edition, 1982; 2nd edition, 1995). This book is by and for mathematicians, with surprisingly little overlap between its bibliography and that of the present book. Suitable for people who like differential equations and linear algebra.
- Dixit**, Avinash & Susan Skeath, *Games of Strategy*. Norton. 600 pages. Nicely laid out with color and boldfacing. Game theory plus chapters on bargaining, auctions, voting, etc. Detailed verbal explanations of many games.
- Dutta**, Prajit, *Strategies and Games: Theory And Practice*. MIT Press. 450 pages.

Muthoo, Abhinay, *Bargaining Theory with Applications*. Cambridge University Press, 357 pages. As the title says: a place to go to look up bargaining models.

Stahl, Saul, *A Gentle Introduction to Game Theory*. American Mathematical Society. 176 pages. In the mathematics department tradition, with many exercises and numerical answers.

Wolfstetter, Elmar, *Topics in Microeconomics: Industrial Organization, Auctions, and Incentives*, Cambridge: Cambridge University Press. 370 pages. I like the chapter on auctions and stochastic dominance, in particular.

As I updated this to the 21st century for the Fourth Edition, I realized that I would have to be more selective. I've listed more books below, but have made less effort to be comprehensive. Mike Shor's website at <http://www.gametheory.net/cgi-bin/viewbooks.pl> is a good place to look for additional books.

- 2000 Gintis**, Herbert, *Game Theory Evolving*. Princeton University Press. 531 pages. A wonderful book of problems and solutions, with much explanation and special attention to evolutionary biology.
- Vives**, Xavier, *Oligopoly Pricing: Old Ideas and New Tools*. MIT Press. 441 pages. The standard for that topic.
- 2001 Laffont**, Jean-Jacques & David Martimort, *The Theory of Incentives: The Principal-Agent Model*. Princeton University Press. 421 pages. Special for its comments on historical development and for the perceptive intuitions mixed in among the equations.
- Rasmusen**, Eric, *Games and Information*. Blackwell Publishing, 3rd edition. 445 pages.
- Rasmusen**, Eric, ed. *Readings in Games and Information*. Blackwell Publishing. 427 pages. Journal and newspaper articles on game theory and information economics. A cartoon for each topic, too!
- 2002 Aumann**, Robert & Sergiu Hart, eds., *Handbook of Game Theory with Economic Applications*, Volume 3. North-Holland. 733 pages. A collection of articles by prominent scholars on topics in game theory.
- Krishna**, Vijay, *Auction Theory*. Academic Press. 297 pages. The standard text for auction theory.
- McAfee**, R. Preston, *Competitive Solutions: The Strategist's Toolkit*. Princeton University Press. 404 pages. An excellent "strategy for managers" book that lays out ideas from game theory and information economics using words and business examples. It's as worth reading cover to cover for a professor as for an MBA student.
- Watson**, Joel. *Strategy: An Introduction to Game Theory*. W. W. Norton & Co. 334 pages. A book by a well-known contract theorist that is similar in topics and level to *Games and Information*.
- 2003 Milgrom**, Paul, *Putting Auction Theory to Work*. Cambridge University Press. 368 pages. Careful about the mathematical foundations, and covers many special cases (multiple objects, type correlations).
- Osborne**, Martin, *An Introduction to Game Theory*. Oxford University Press. 504 pages. His second game theory book, this one is for undergraduates, precise but with little calculus.

- 2004 Klemperer**, Paul, *Auctions: Theory and Practice*. Princeton University Press. 246 pages. Mostly verbal, but especially good in the mathematics it does include.
- 2005 Bolton**, Patrick & Mathias Dewatripont, *Contract Theory*. MIT Press. 688 pages. A detailed exposition of principal–agent models.
- 2006 Rasmusen**, Eric, *Games and Information*. Blackwell Publishing, 4th edition (1st edition, 1989; 2nd edition, 1994; 3rd edition, 2001). Read on.

Contact Information

The website for the book is at

<http://www.rasmusen.org/GI>

The site has the answers to the odd-numbered problems at the end of the chapters, and has instructors’ notes for the classroom games. For answers to even-numbered questions, instructors or others needing them for good reasons should email me at Erasmuse@Indiana.edu; send me snailmail at Eric Rasmusen, Department of Business Economics and Public Policy, Kelley School of Business, Indiana University, 1309 East 10th Street, Bloomington, Indiana, USA 47405-1701; or fax me at (812)855-3354.

If you wish to contact the publisher of this book, the addresses are Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK; or 350 Main Street, Malden, Massachusetts 02148, U.S.A.

The text files on the website are two forms (1) *.tex, LaTeX, which uses only ASCII characters, but does not have the diagrams, and (2) *.pdf, Adobe Acrobat, which is formatted and can be read using a free reader program. I encourage readers to submit additional homework problems as well as errors and frustrations. They can be sent to me by e-mail at Erasmuse@Indiana.edu.

Acknowledgements

I would like to thank the many people who commented on clarity, suggested topics and references, or found mistakes. I’ve put affiliations next to their names, but remember that these change over time (A.B. was not a finance professor when he was my research assistant!).

First Edition: Dean Amel (Board of Governors, Federal Reserve), Dan Asquith (S.E.C.), Sushil Bikhchandani (UCLA business economics), Patricia Hughes Brennan (UCLA accounting), Paul Cheng, Luis Fernandez (Oberlin economics), David Hirshleifer (Ohio State finance), Jack Hirshleifer (UCLA economics), Steven Lippman (UCLA management science), Ivan Png (Singapore), Benjamin Rasmusen (Roseland Farm), Marilyn Rasmusen (Roseland Farm), Ray Renken (Central Florida physics), Richard Silver, Yoon Suh (UCLA accounting), Brett Trueman (Berkeley accounting), Barry Weingast (Hoover) and students in Management 200a made useful comments. D. Koh, Jeanne Lamotte, In-Ho Lee, Loi Lu, Patricia Martin, Timothy Opler (Ohio State finance), Sang Tran, Jeff Vincent, Tao Yang, Roy Zerner, and especially Emmanuel Petrakis (Crete economics) helped me with research assistance at one stage or another. Robert Boyd (UCLA anthropology), Mark Ramseyer

(Harvard law), Ken Taymor, and John Wiley (UCLA law) made extensive comments in a reading group as each chapter was written.

Second Edition: Jonathan Berk (U. British Columbia commerce), Mark Burkey (Appalachian State economics), Craig Holden (Indiana finance), Peter Huang (Penn Law), Michael Katz (Berkeley business), Thomas Lyon (Indiana business economics), Steve Postrel (Northwestern business), Herman Quirnbach (Iowa State economics), H. Shifrin, George Tsebelis (UCLA poli sci), Thomas Voss (Leipzig sociology), and Jong-Shin Wei made useful comments, and Alexander Butler (Louisiana State finance) and An-Sing Chen provided research assistance. My students in Management 200 at UCLA and G601 at Indiana University provided invaluable help, especially in suffering through the first drafts of the homework problems.

Third Edition: Kyung-Hwan Baik (Sung Kyun Kwan), Patrick Chen, Robert Dimand (Brock economics), Mathias Erlei (Muenster), Francisco Galera, Peter-John Gordon (University of the West Indies), Erik Johannessen, Michael Mesterton-Gibbons (Pennsylvania), David Rosenbaum (Nebraska economics), Richard Tucker, Hal Wasserman (Berkeley), and Chad Zutter (Indiana finance) made comments that were helpful for the third edition. Blackwell supplied anonymous reviewers of superlative quality. Scott Fluhr, Pankaj Jain and John Spence provided research assistance and new generations of students in G601 were invaluable in helping to clarify my writing.

Fourth Edition: Abdullahi Abdulkadri (U. of the West Indies), Michael Alvarez (Bergen), Michael Baye (Indiana), David Collie (Cardiff), Bouwe Dijkstra (Nottingham), Yanqiong Ding (Shantung), Ralf Elsas (Goethe), Sean Gailmard (Chicago), Diego Garcia (Dartmouth), Richmond Harbaugh (Indiana), Paul Klemperer (Oxford), Bettina Kromen (Cologne), Eva Labro (LSE), Andrew Lilico (Europe Economics), Robert Losee (UNC-CH), Ron Mallon (Utah), Frank P. Maier-Rigaud (Friedrich Wilhelms U.), Ian McCarthy (Indiana), Alexandra Minicozzi (Texas), Luis Pacheco (Portugalense), Tommy Pousset (Louvain), Michael Rothkopf (Rutgers), Pedro Sousa (Portugalense), Charles Tharp, Randal Verbrugge (BLS), Victor Yip (Hong Kong), Lily Yu (Cornell), and especially Maria Arbatskaya (Emory), Kyung Baik (Sungkyunkwan), Martin Caley (Isle of Man Treasury) and Michael Rauh (Indiana) made useful comments. Lan Chang, Ariel Kemper, Manu Raghav, Michael Swetz, and Benjamin Warolin provided research assistance. As always, my students were an important part of writing this book.

Eric Rasmusen

Dan R. and Catherine M. Dalton Professor
Department of Business Economics and Public Policy
Kelley School of Business, Indiana University
Bloomington, Indiana

