

## Market Design

Economists are involved in designing as well as studying market mechanisms. These include auctions to sell diamonds, timber, electricity, procurement contracts and radio spectrum; matching algorithms to assign students to schools, or candidates to jobs; and mechanisms to sell internet advertising, trade financial securities, or reward innovation. The field of market design studies how to construct rules for allocating resources or to structure successful marketplaces. It draws on the tools of game theory and mechanism design to identify why certain market rules or institutions succeed and why others fail.

The class divides roughly into three parts: matching, auctions and platforms. In studying matching and auction markets, we focus mainly on well-defined resource allocation problems. There is a set of resources to be allocated and people that want them. The resources aren't perfectly divisible, so we can't just give everyone a share of everything, and there is a diversity of preferences, so there is a question of who should get what. The goal typically is to design an economic mechanism that gives people an opportunity to express their preferences and achieves a desirable or efficient outcome.

In the section on matching, we'll analyze settings where there's no money. Instead of setting prices, we have to ask people what they want and try to satisfy their preferences subject to limited resources. Examples include assigning students to public schools, placing doctors in residency positions, matching couples on dating websites, or assigning donated kidneys to transplant patients. We'll study a set of algorithms that have desirable theoretical properties and are often used in practice to solve these problems.

The second part of the class is on auctions. We'll start with problems where someone wants to sell a single item (a house, a company, a painting), and then discuss more complex problems of allocating many goods, such as financial market mechanisms, the auctions used by Google, Microsoft and Facebook to sell advertising, and the multi-item auctions used to sell property rights to radio spectrum, as well as other assets.

In the final part of the class, we'll talk about market platforms and talk about network effects, as well as the design of efficient marketplaces. Examples will consider include ecommerce platforms, and peer-to-peer online markets.

One goal in this class is to introduce you to some of the tools of game theory and mechanism design, and connect this theory to practical applications. A lot of the lectures will be devoted to laying out theoretical models. We will also discuss relevant case studies, empirical evidence and in some cases, laboratory or field experiments. The hope is that once you get familiar with the ideas, you'll be able to identify lots of examples where market design ideas are relevant and useful.

### *Who Should and Shouldn't Take this Class*

This class is designed for sophomores, juniors and seniors majoring in Economics, or with a strong quantitative background. There is a good deal of economic theory; you should expect theoretical arguments in every class. Econ 51 is strongly recommended as background. The class is complementary to Econ 160 (Game Theory), although Econ 160 is more concerned with the foundational ideas of Game Theory and this class is more about applications. I won't assume you know game theory, but you might enjoy taking both classes if you're an economics major. If you're still wondering whether you should be taking this course, you should be able to get a good sense from the first few classes.

### *Requirements and Grading*

The class meets TTh 1.15-3.05. You are expected to attend and participate. I like people to ask questions, and I will ask questions myself. The one rule in class is that I don't permit laptops, iPads, iPhones, etc. I'll try to post slides for the lectures in advance, so if you like to take notes, you can print them out beforehand. I understand that you may prefer to take notes on your laptop, but I also think the classroom experience is seriously diminished when everyone is texting or checking email.

Now the more standard requirements: there will be an assignment each week, due on Thursday. The first assignment will be due April 10, the last one on May 31. The assignments generally will have one or two mathematical problems based on the models from the lectures, to reinforce the theory, and a more open-ended question aimed at getting you to think about real-world market design problems. You may work with one or two classmates, but must write up the assignment individually.

The main requirement beyond the assignments is a term paper, due with no exceptions on **June 3**. You are expected to submit a short proposal on **May 13**. The separate "paper requirement" handout describes the paper and the required proposal in more detail.

Grading: The weekly assignments count for 60% of the grade; the paper counts for the other 40%. In case you're wondering, the grade distribution for the class has tended to be around half As (A+ to A-) and the rest mostly Bs (B+ to B-). The class is a bit atypical for an Economics elective in having a final paper rather than a final exam, but I think the grading and grade distribution are comparable.

### *The TA, Sections and Office Hours*

The TA for the class is Chiara Farronato. Her email is [chiaraf@stanford.edu](mailto:chiaraf@stanford.edu). Chiara will hold sections on Friday.

- Section 1: Friday 9-9.50 am in Encina West 108
- Section 2: Friday 10-10.50 am in Encina West 108

Chiara's office hours Thursday 5-7 pm (location TBA).

My office hours are Tuesday after class until 4.30 pm in my office (Landau 240).

We also have a grader, Bobby Pakzad-Hurson. His email is bph1@stanford.edu.

*Textbook (or Lack Thereof), and Readings*

There is no text for this class. I'll distribute slides for each class that cover all the material and everything you will need to do the assignments. I'll also post handouts that provide either overviews of certain subjects or more technical detail on specific material. All of this material will be available on the Piazza website.

There is a small amount of recommended reading for each class. The readings are mostly economics journal articles, or popular press articles, that provide some context for the class. All of the listed papers (at least large parts of them) should be readable. They are easily available online, and I'll ask about them in class.

Finally, we'll use Piazza to post links to popular press articles or interesting websites that tie in with the ideas in the class. In the past, this has been a great way to find ideas for papers and see connections between the class and real markets.

## *Schedule for Lectures*

### **1. (Tu 4/1) Introduction: Market Design**

*Topics:* Market game, discussion, overview of the class, game theory intro.

### **2. (Th 4/3) Introduction to Matching Markets**

*Topics:* The “marriage market” and one-to-one matching, stable matches, the Deferred Acceptance algorithm, optimal matches for men and women, incentives.

*Reading:* David Gale and Lloyd Shapley, "College Admissions and the Stability of Marriage," *American Mathematical Monthly*, 69, 1962, pp. 9-15. [This is the first paper on matching markets and apart from its historic interest it is a *great* paper – a math paper that doesn't have a single equation! Not to be missed.]

### **3. (Tu 4/8) Stable Matching and Orderly Markets**

*Topics:* Stable matchings and orderly markets, the problem of market unraveling, medical residents and the NRMP, medical fellowships, law clerks, college admissions.

*Reading:* Alvin Roth and Elliott Peranson, The Re-Design of the Matching Market for American Physicians: Some Engineering Aspects of Economic Design *American Economic Review*, 89, 4, September, 1999, 748-780. [Describes the redesign of the matching algorithm used to assign residents to hospitals – a challenging read.]

Two short articles by Sara Robinson: “Are Medical Students Meeting Their (Best Possible) Match?” (*Siam News*, April 2003) and Tweaking the Math to Make Happier Medical Marriages,” (*New York Times*, August 24, 2004).

Christopher Avery, Christine Jolls, Richard Posner and Alvin Roth, “The Market for Federal Judicial Law Clerks” and “The New Market for Federal Judicial Law Clerks,” *University of Chicago Law Review*, Summer 2001 (793-902) and Spring 2007 (447-486). [Long but interesting articles on the unraveling of the federal law clerk market.]

Christopher Avery and Jonathan Levin, "Early Admissions at Selective Colleges," *American Economic Review*, December 2010. [Describes the basic facts about college early admissions and offers a theory. The first few sections should be accessible.]

The *New York Times* “The Choice” blog often has great posts on college admissions.

### **4. (Th 4/10) House Allocation and Kidney Exchange**

*Topics:* The house allocation problem, efficient outcomes and the core, serial dictatorship, the top trading cycles algorithm and variations, kidney exchanges.

*Reading:* Alvin Roth, Tayfun Sonmez and Utku Unver, "A Kidney Exchange Clearinghouse in New England," *American Economic Review*, 95(2) May 2005, 376-380. [Short article that describes the design of the New England clearinghouse, including the Top Trading Cycles theory used to find matches.]

Short article on National Science Foundation Website: "Kidney Exchange: A Life-Saving Application of Matching Theory," (Google "Kidney Exchange NSF").

## **5. (Tu 4/15) School Choice**

*Topics:* School choice, the Boston algorithm and its incentive problems, deferred acceptance and top trading cycles as alternatives, problem of ties, Boston & NYC.

*Reading:* Atila Abdulkadiroğlu, Parag Pathak and Alvin Roth, "The New York City High School Match," and (with Tayfun Sonmez) "The Boston Public School Match," *American Economic Review*, 95(2), May 2005, 364-367 and 368-371, [Two short articles discussing the design of the New York and Boston school choice systems. These articles are written for professional economists but are at an accessible level.]

Short article on American Mathematical Society website, "School Choice" by Joseph Malkevitch (Google: "School Choice AMS").

## **6. (Friday 4/18) Guest Lecture: Al Roth on Kidney Exchange**

*Note:* This class likely will be on Friday during section time (with Section on Thursday during class time) to accommodate Al's travel schedule.

Al Roth is the McCaw Professor of Economics at Stanford, and winner of the 2012 Nobel Prize in Economics for his work on matching. The Nobel Prize web page has a lot of material on Al's work, and links to his Nobel lecture [http://www.nobelprize.org/nobel\\_prizes/economic-sciences/laureates/2012/](http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2012/)

## **7. (Tu 4/22) Auction Theory (Chiara)**

*Topics:* The private value model of auctions, ascending auctions, first and second price sealed bid auctions, the revenue equivalence theorem, auction design decisions: encouraging entry, setting reserve prices, subsidizing small bidders.

*Reading:* National Academy of Sciences Beyond Discovery Report "The Bidding Game," March 2003. (Google: bidding game).

Klemperer, Paul, "What Really Matters in Auction Design," *Journal of Economic Perspectives*, 2002. [Easy to read article that discusses many of the practical economic concerns in designing a large-scale auction.]

### **8. (Th 4/24) Applications of Auction Theory (Chiara)**

*Topics:* Optimal auction design, collusion and bidding rings.

*Reading:* TBA.

### **9. (Tu 4/29) Common Value Auctions**

*Topics:* The common value model of auctions, the winner's curse, examples and applications, when do prices aggregate information, application to oil lease auctions.

*Reading:* Hendricks, Ken, and Robert Porter, "An Empirical Study of an Auction with Asymmetric Information," *American Economic Review*, 1988. [Classic study of the winner's curse in bidding for off-shore oil leases. We'll talk about the results in class.]

Richard Thaler, "Anomalies: The Winner's Curse," *Journal of Economic Perspectives*, 2(1), Winter 1988, 191-202. [Accessible article describing experimental and empirical evidence on the winner's curse, by one of the pioneering behavioral economists.]

### **10. (Th 5/1) Financial Markets and High-Frequency Trading**

*Topics:* Electronic markets for trading equity and other financial securities, the use of auctions for IPOs, real-time trading and market clearing, competition between exchanges.

*Reading:* Securities and Exchange Commission, Concept Release on Market Structure, 2010 (Google: SEC concept release market structure). [Incredibly interesting white paper on how the introduction of electronic platforms has changed financial markets.]

Eric Budish, Peter Cramtom and John Shim, "The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response," Working Paper, 2013.

### **11. (Tu 5/6) Multi-Unit Auctions and Treasury Auctions**

*Topics:* Sequential auctions, uniform price auctions, discriminatory price auctions, demand reduction, Vickrey pricing and efficient auction design.

*Reading:* TBA

## **12. (Th 5/8) Multi-Item Auctions and Assignment Markets**

*Topics:* The assignment model (matching with prices), competitive equilibria and efficiency, ascending auctions, assignment auctions, connection with matching and the deferred acceptance algorithm.

*Reading:* Overview of Matching Theory handout.

## **13. (Tu 5/13) Sponsored Search Auctions**

*Topics:* The sponsored search market, Google's advertising auction, bidding incentives and equilibria, other ways to run the auction, Facebook's Vickrey auction.

*Readings:* Hal Varian, "The Economics of Internet Search," Angelo Costa Lecture, 2007.

Ben Edelman, Michael Ostrovsky and Michael Schwarz, "Internet Advertising and the Generalized Second Price Auction," *American Economic Review*, 2007. [Game theory analysis of Google's search auction – challenging.]

Tom Blake, Chris Nosko and Steve Tadelis, "Consumer Heterogeneity and Paid Search Effectiveness: A Large-Scale Field Experiment," Working Paper, 2013. [Reports on a field experiment where eBay randomly turned off their Google paid search ads.]

Jonathan Levin and Paul Milgrom: "Online Advertising: Heterogeneity and Conflation in Market Design," *American Economic Review P&P*, 2010. [Discusses the design of markets for highly customized products such as targeted online advertising.]

## **14. (Th 5/15) Auctions for Radio Spectrum**

*Topics:* Auctions to award property rights for radio spectrum, design of the FCC auctions, evidence from US and Europe, the Advanced Wireless Service auction.

*Readings:* Ken Binmore and Paul Klemperer, "The Biggest Auction Ever: The Sale of the British 3G Telecom Licenses," *Economic Journal*, 2002. [Article by leading European auction theorists on the design of the British 3G auction.]

Jeremy Bulow, Jonathan Levin and Paul Milgrom, "Winning Play in Spectrum Auctions," Working Paper, March 2009. [Spectrum auctions from the perspective of the bidders, and some surprising anomalies – most parts should be readable.]

Peter Cramton, "Spectrum Auction Design," Working Paper, 2011. [New ideas about how to design combinatorial auctions for radio spectrum and other assets.]

## **15. (Tu 5/20) Introduction to the Economics of Platforms**

*Topics:* Designing platforms for exchange, network effects, optimal pricing by the platform owner, competition between platforms for users, market tipping.

*Readings:* David Evans and Richard Schmalensee, “The Industrial Organization of Markets with Two-Sided Platforms,” *Competition Policy International*, 3(1), Spring 2007. [High-level overview of platform competition and especially antitrust issues.]

Jonathan Levin, “The Economics of Internet Markets,” [Section 2 has a discussion of what we know about the economics of platforms, and the model from class.]

Suh et al. “The Singularity is Not Near: Slowing Growth of Wikipedia” *WikiSym '09*. [Fascinating study of how Wikipedia editing has evolved over time.]

## **16. (Th 5/22) Internet Commerce Markets**

*Topics:* Creating internet markets for e-Commerce, eBay and internet auctions, reputation systems, Amazon and internet retail, search, pricing and sales mechanisms.

*Readings:* Gary Bolton, Ben Greiner and Axel Ockenfels, “Engineering Trust: Strategic Behavior and the Production of Reputation Information,” Working Paper, 2010. [Interesting study of the re-design of eBay’s reputation system.]

Liran Einav, Chiara Farronato, Jonathan Levin and Neel Sundaresan, “Sales Mechanisms in Online Markets: What Happened to Internet Auctions?” Working Paper, 2013. [Demise of consumer auctions in internet commerce, based on eBay “experiments”.]

## **17. (Tu 5/27) Peer-to-peer Online Markets**

*Topics:* Creating peer-to-peer markets: online labor markets, Airbnb, Uber, etc.

*Readings:* TBA.

## **18. (Th 5/29) Guest Lecture: Susan Athey on Virtual Currencies**

Susan Athey is Professor of Economics at the Stanford GSB. She previously taught in the Economics Departments at MIT, Stanford and Harvard. She was the first female winner of the John Bates Clark Medal, and was elected to the National Academies of Science at the age of 41. She was Chief Economist for Microsoft from 2008-2013.



*Reading:* Marc Andreessen, “Why Bitcoin Matters,” New York Times Dealbook, January 21, 2014.

Joshua Kroll, Ian Davies, Edward Felten, “The Economics of Bitcoin Mining,” Working Paper, 2013.

**19. (Tu 6/3) No Class: FINAL PAPER DUE!**