

Economics 2099 – Market Design

Scott Duke Kominers

Logistics

Time. Tuesdays, 16:00–18:45± ϵ (beginning September 8, 2015).

Location. Littauer M-16.

Office Hours.

- By appointment – Please email kominers@fas.harvard.edu to schedule, using the subject line “2099 Office Hours.”
- Over dinner – After class each week (if there is interest), there will be an *optional*, informal “design dinner” in Harvard Square. (Restaurants will be selected via social choice mechanism.)
- At the climbing gym – Most Sunday evenings, I will be climbing at Brooklyn Boulders Somerville (12A Tyler Street); please feel free to drop by. (To confirm in advance, please e-mail kominers@fas.harvard.edu, using the subject line “2099 Climbing.”)

Course Webpage.

- http://www.scottkom.com/courses/Market-Design_2015-2016/

Teaching Assistant.

- Ben Roth (benroth@mit.edu).

Overview

Description. This course explores the theory and practice of market design. Key topics include auctions, labor market matching, school choice programs, online markets, organ exchange systems, financial market design, and matching with contracts. The first half of the course will introduce market design and its technology; subsequent weeks will discuss recent papers alongside their classical antecedents.

Quasi-Prerequisites. Courses in microeconomics (Economics 1011a and/or 2010a,b), game theory (Economics 1052, 2052 and/or 2087hf), and/or normative economics (Economics 2070) will provide useful context and technical background. Some understanding of algorithms, complexity, and/or combinatorics (e.g., Computer Science 124, 186, 284 and/or 286r) will at times be useful. However, *I do not believe in formal prerequisites*—these observations are made only for the purpose of guidance.

If you are interested in taking the course and are concerned about the difficulty of the material, please get in touch with me early in (or before) the fall semester. I am inclined to reward individuals for taking risks and stretching themselves.

Requirements. Evaluation will be primarily based upon class participation and discussion. Additionally, each student will prepare a written “research proposal” detailing a novel problem in market design and an approach to a solution. A short abstract of the proposal will be due on October 6, 2015, and a short summary will be due on November 10, 2015. The final proposal will be due on December 10, 2015 (the last day of Reading Period).

How to Read this Syllabus. “Background” readings will be taught in class. Readings listed as “For Class Discussion” will be discussed intensively, and thus should be read in advance. “Further Reading” references may be touched upon in class sessions, but are mostly provided as suggestions for students who wish to explore in more depth.

Topics

Introduction/Overview – September 8, 2015.

For Class Discussion.

David Gale and Lloyd S. Shapley. College admissions and the stability of marriage. *American Mathematical Monthly*, 69:9–15, 1962.

Background.

Ronald H. Coase. The problem of social cost. *Journal of Law and Economics*, 3:1–44, 1960.

Alvin E. Roth. The evolution of the labor market for medical interns and residents: A case study in game theory. *Journal of Political Economy*, 92:991–1016, 1984.

Alvin E. Roth. The economist as engineer: Game theory, experimentation, and computation as tools for design economics. *Econometrica*, 70:1341–1378, 2002.

Alvin E. Roth. Deferred acceptance algorithms: History, theory, practice, and open questions. *International Journal of Game Theory*, 36:537–569, 2008.

Further Reading.

Christopher Avery, Christine Jolls, Richard A. Posner, and Alvin E. Roth. The market for federal judicial law clerks. *University of Chicago Law Review*, 68:793–902, 2001.

L. E. Dubins and D. A. Freedman. Machiavelli and the Gale-Shapley algorithm. *American Mathematical Monthly*, 88:485–494, 1981.

John H. Kagel and Alvin E. Roth. The dynamics of reorganization in matching markets: A laboratory experiment motivated by a natural experiment. *Quarterly Journal of Economics*, 115:201–235, 2000.

Alvin E. Roth and Xiaolin Xing. Jumping the gun: Imperfections and institutions related to the timing of market transactions. *American Economic Review*, 84:992–1044, 1994.

Alvin E. Roth and Elliott Peranson. The redesign of the matching market for American physicians: Some engineering aspects of economic design. *American Economic Review*, 89:748–780, 1999.

The Market Designer’s Toolbox – September 15, 2015.

For Class Discussion.

Parag A. Pathak and Tayfun Sönmez. Leveling the playing field: Sincere and sophisticated players in the Boston mechanism. *American Economic Review*, 98:1636–1652, 2008.

Background.

Parag A. Pathak and Tayfun Sönmez. School admissions reform in Chicago and England: Comparing mechanisms by their vulnerability to manipulation. *American Economic Review*, 103:80–106, 2013.

Fuhito Kojima and Parag A. Pathak. Incentives and stability in large two-sided matching markets. *American Economic Review*, 99:608–627, 2009.

Alexander S. Kelso and Vincent P. Crawford. Job matching, coalition formation, and gross substitutes. *Econometrica*, 50:1483–1504, 1982.

Shengwu Li. Obviously strategy-proof mechanisms. Stanford University Working Paper, 2015.

Benjamin N. Roth and Ran I. Shorrer. Mechanism design in the presence of a pre-existing game. MIT Working Paper, 2015.

Jonathan M. V. Davis and B. Pablo Montagnes. Organizational market design. University of Chicago Working Paper, 2015.

John William Hatfield, Fuhito Kojima, and Scott Duke Kominers. Strategy-proofness, investment efficiency, and marginal returns: An equivalence. Becker Friedman Institute Working Paper, 2015.

Further Reading.

Itai Ashlagi, Yash Kanoria, and Jacob D. Leshno. Unbalanced random matching markets: The stark effect of competition. MIT Working Paper, 2014.

Eduardo M. Azevedo and Jacob D. Leshno. A supply and demand framework for two-sided matching markets. *Journal of Political Economy*, forthcoming.

Eric Budish. The combinatorial assignment problem: Approximate competitive equilibrium from equal incomes. *Journal of Political Economy*, 119:1061–1103, 2011.

Eric Budish and Estelle Cantillon. The multi-unit assignment problem: Theory and evidence from course allocation at Harvard. *American Economic Review*, 102:2237–71, 2012.

Eric Budish, Yeon-Koo Che, Fuhito Kojima, and Paul Milgrom. Designing random allocation mechanisms: Theory and applications. *American Economic Review*, 103:585–623, 2013.

Nicole Immorlica and Mohammad Mahdian. Incentives in large random two-sided markets. *ACM Transactions on Economics and Computation*, 3:#14, 2015.

School Choice – September 22, 2015.

(Featuring Nikhil Agarwal & Parag Pathak.)

For Class Discussion.

Atila Abdulkadiroğlu, Nikhil Agarwal, and Parag A. Pathak. The welfare effects of congestion in uncoordinated assignment: Evidence from the NYC HS match. MIT Working Paper, 2014.

Nikhil Agarwal and Paulo Somaini. Demand analysis using strategic reports: An application to a school choice mechanism. NBER Working Paper No. 20775, 2014.

Background.

Michel Balinski and Tayfun Sönmez. A tale of two mechanisms: Student placement. *Journal of Economic Theory*, 84:73–94, 1999.

Atila Abdulkadiroğlu and Tayfun Sönmez. School choice: A mechanism design approach. *American Economic Review*, 93:729–747, 2003.

Onur Kesten. School choice with consent. *Quarterly Journal of Economics*, 125:1297–1348, 2010.

Fuhito Kojima. School choice: Impossibilities for affirmative action. *Games and Economic Behavior*, 75:685–693, 2012.

Isa Emin Hafalir, M. Bumin Yenmez, and Muhammed Ali Yildirim. Effective affirmative action in school choice. *Theoretical Economics*, 8:325–363, 2013.

Further Reading.

Atila Abdulkadiroğlu, Parag A. Pathak, and Alvin E. Roth. The New York City high school match. *American Economic Review*, 95:364–367, 2005.

Atila Abdulkadiroğlu, Parag A. Pathak, Alvin E. Roth, and Tayfun Sönmez. The Boston public school match. *American Economic Review*, 95:368–371, 2005.

Atila Abdulkadiroğlu, Parag A. Pathak, and Alvin E. Roth. Strategyproofness versus efficiency in matching with indifferences: Redesigning the NYC high school match. *American Economic Review*, 99:1954–1978, 2009.

Caterina Calsamiglia and Maia Güell. The illusion of school choice: Empirical evidence from Barcelona. CEPR Discussion Paper No. DP10011, 2014.

- Umut Dur, Scott Duke Kominers, Parag A. Pathak, and Tayfun Sönmez. The demise of walk zones in Boston: Priorities vs. precedence in school choice. Boston College Working Paper, 2015.
- Federico Echenique and M. Bumin Yenmez. How to control controlled school choice. *American Economic Review*, forthcoming.
- John William Hatfield, Fuhito Kojima, and Yusuke Narita. Promoting school competition through school choice: A market design approach. Stanford University Working Paper, 2015.
- Scott Duke Kominers and Tayfun Sönmez. Matching with slot-specific priorities: Theory. *Theoretical Economics*, 11:683–710, 2016.
- Scott Duke Kominers and Tayfun Sönmez. Matching with slot-specific priorities: Applications. Harvard University Working Paper, 2015.
- Parag A. Pathak. The mechanism design approach to student assignment. *Annual Review of Economics*, 3:513–536, 2011.
- Parag A. Pathak and Jay Sethuraman. Lotteries in student assignment: An equivalence result. *Theoretical Economics*, 6:1–17, 2011.

Generalized Matching – September 29, 2015.

For Class Discussion.

- Tayfun Sönmez and Tobias B. Switzer. Matching with (branch-of-choice) contracts at United States Military Academy. *Econometrica*, 81:451–488, 2013.
- Tayfun Sönmez. Bidding for army career specialties: Improving the ROTC branching mechanism. Boston College Working Paper, 2011.

Background.

- John William Hatfield and Paul Milgrom. Matching with contracts. *American Economic Review*, 95:913–935, 2005.
- John William Hatfield and Fuhito Kojima. Substitutes and stability for matching with contracts. *Journal of Economic Theory*, 145:1704–1723, 2010.
- John William Hatfield and Scott Duke Kominers. Contract design and stability in many-to-many matching. *Games and Economic Behavior*, forthcoming.
- Michael Ostrovsky. Stability in supply chain networks. *American Economic Review*, 98:897–923, 2008.

Further Reading.

- Hiroyuki Adachi. On a characterization of stable matchings. *Economics Letters*, 68:43–49, 2000.
- Orhan Aygün and Tayfun Sönmez. Matching with contracts: Comment. *American Economic Review*, 103:2050–2051, 2013.
- Elizabeth Baldwin and Paul Klemperer. Tropical geometry to analyse demand. Oxford University Working Paper, 2014.
- Federico Echenique. Contracts vs. salaries in matching. *American Economic Review*, 102:594–601, 2012.
- Tamás Fleiner. A fixed-point approach to stable matchings and some applications. *Mathematics of Operations Research*, 28:103–126, 2003.
- Frank Gul and Ennio Stacchetti. Walrasian equilibrium with gross substitutes. *Journal of Economic Theory*, 87:95–124, 1999.
- John William Hatfield and Scott Duke Kominers. Matching in networks with bilateral contracts. *American Economic Journal: Microeconomics*, 4:176–208, 2012.
- John William Hatfield and Scott Duke Kominers. Hidden substitutes. Harvard University Working Paper, 2015.

- John William Hatfield, Scott Duke Kominers, Alexandru Nichifor, Michael Ostrovsky, and Alexander Westkamp. Stability and competitive equilibrium in trading networks. *Journal of Political Economy*, 121:966–1005, 2013.
- Yuichiro Kamada and Fuhito Kojima. Efficient matching under distributional constraints: Theory and applications. *American Economic Review*, 105:67–99, 2015.
- Ning Sun and Zaifu Yang. Equilibria and indivisibilities: Gross substitutes and complements. *Econometrica*, 74:1385–1402, 2006.
- Alexander Teytelboym, Tamás Fleiner, Zsuzsanna Janko, and Akihisa Tamura. Trading networks with bilateral contracts. Oxford University Working Paper, 2015.
- M. Bumin Yenmez. College admissions. GSIA Working Paper #2014-E24, 2014.

Signaling in Matching Markets – October 6, 2015.

For Class Discussion.

- Soohyung Lee and Muriel Niederle. Propose with a rose? Signaling in Internet dating markets. *Experimental Economics*, forthcoming.

Background.

- Peter Coles, Alexey Kushnir, and Muriel Niederle. Preference signaling in matching markets. *American Economic Journal: Microeconomics*, 5:99–134, 2013.
- Peter Coles, John Cawley, Phillip B. Levine, Muriel Niederle, Alvin E. Roth, and John J. Siegfried. The job market for new economists: A market design perspective. *Journal of Economic Perspectives*, 24:187–206, 2010.
- Alexey Kushnir. Harmful signaling in matching markets. *Games and Economic Behavior*, 80:209–218, 2013.

Further Reading.

- Sarbartha Bandyopadhyay, Fedor Ishakov, Terence Johnson, Soohyung Lee, David McArthur, John Rust, Joel Watson, and John Watson. Can the job market for economists be improved? In Nir Vulkan, Alvin E. Roth, and Zvika Neeman, editors, *The Handbook of Market Design*, pages 189–221. Oxford University Press, 2013.
- Raymond Fisman, Sheena S. Iyengar, Emir Kamenica, and Itamar Simonson. Gender differences in mate selection: Evidence from a speed dating experiment. *Quarterly Journal of Economics*, 121:673–697, 2006.
- Günter J. Hitsch, Ali Hortaçsu, and Dan Ariely. Matching and sorting in online dating. *American Economic Review*, 100:130–163, 2010.
- John Joseph Horton and Ramesh Johari. At what quality and what price?: Eliciting buyer preferences as a market design problem [extended abstract]. In *Proceedings of the Sixteenth ACM Conference on Economics and Computation*, page 507. ACM, 2015.

Auction Theory – October 13, 2015.

For Class Discussion.

- Benjamin Edelman, Michael Ostrovsky, and Michael Schwarz. Internet advertising and the generalized second-price auction: Selling billions of dollars worth of keywords. *American Economic Review*, 97:242–259, 2007.
- Susan Athey and Glenn Ellison. Position auctions with consumer search. *Quarterly Journal of Economics*, 126:1213–1270, 2011.
- Michael Ostrovsky and Michael Schwarz. Reserve prices in Internet advertising auctions: A field experiment. Stanford Graduate School of Business Working Paper, 2009.

Background.

- R. Preston McAfee and John McMillan. Auctions and bidding. *Journal of Economic Literature*, 25:699–738, 1987.
- Roger B. Myerson. Optimal auction design. *Mathematics of Operations Research*, 6:58–73, 1981.
- Jeremy Bulow and John Roberts. The simple economics of optimal auctions. *Journal of Political Economy*, 97:1060–1090, 1989.
- Jeremy Bulow and Paul Klemperer. Auctions versus negotiations. *American Economic Review*, 86:180–194, 1996.
- Paul R. Milgrom and Robert J. Weber. A theory of auctions and competitive bidding. *Econometrica*, 50:1089–1122, 1982.

Further Reading.

- Jeremy Bulow and Paul Klemperer. Why do sellers (usually) prefer auctions? *American Economic Review*, 99:1544–1575, 2009.
- Dirk Bergemann and Juuso Välimäki. Information acquisition and efficient mechanism design. *Econometrica*, 70:1007–1033, 2002.
- Benjamin Edelman and Michael Ostrovsky. Strategic bidder behavior in sponsored search auctions. *Decision Support Systems*, 43:192–198, 2007.
- Jerry Green and Jean-Jacques Laffont. Characterization of satisfactory mechanisms for the revelation of preferences for public goods. *Econometrica*, 45:427–438, 1977.
- Paul Milgrom. Assignment messages and exchanges. *American Economic Journal: Microeconomics*, 1:95–113, 2009.
- Roger B. Myerson and Mark A. Satterthwaite. Efficient mechanisms for bilateral trading. *Journal of Economic Theory*, 29:265–281, 1983.
- Steven R. Williams. A characterization of efficient, Bayesian incentive compatible mechanisms. *Economic Theory*, 14:155–180, 1999.
- Robert A. Wilson. Bidding. In John Eatwell, Murray Milgate, and Peter Newman, editors, *The New Palgrave: A Dictionary of Economics*, pages 238–242. Palgrave Macmillan, 1st edition, 1987.

Internet Markets – October 20, 2015.

(Featuring Ben Edelman & Andrey Fradkin.)

For Class Discussion.

- Benjamin G. Edelman and Michael Schwarz. Pricing and efficiency in the market for IP addresses. *American Economic Journal: Microeconomics*, forthcoming.
- Andrey Fradkin. Search frictions and the design of online marketplaces. MIT Working Paper, 2014.

Background.

- Susan Athey. Information, privacy, and the Internet: An economic perspective, 2014. CPB Netherlands Bureau for Economic Policy Analysis.
- Jonathan D. Levin. The economics of Internet markets. In Daron Acemoglu, Manuel Arellano, and Eddie Dekel, editors, *Advances in Economics and Econometrics, Tenth World Congress*, volume 1, pages 48–75. Cambridge University Press, 2013.
- Andrey Fradkin. The economics of platforms (with Greg Lewis). *Economic Frontiers [Podcast]*, 2015.
- Alvin E. Roth and Axel Ockenfels. Last-minute bidding and the rules for ending second price auctions: Evidence from eBay and Amazon auctions on the Internet. *American Economic Review*, 92:1093–1103, 2002.
- Patrick Bajari and Ali Hortaçsu. Economic insights from Internet auctions. *Journal of Economic Literature*, 42:457–486, 2004.

- Liran Einav, Theresa Kuchler, Jonathan D. Levin, and Neel Sundaresan. Learning from seller experiments in online markets. NBER Working Paper No. 17385, 2011.
- Yiling Chen and David M. Pennock. Designing markets for prediction. *AI Magazine*, 31:42–52, 2010.
- Michael Luca. Reviews, reputation, and revenue: The case of Yelp.com. Harvard Business School Working Paper No. 12-016, 2012.
- John J. Horton, David G. Rand, and Richard J. Zeckhauser. The online laboratory: Conducting experiments in a real labor market. *Experimental Economics*, 14:399–425, 2011.
- Amanda Pallais. Inefficient hiring in entry-level labor markets. *American Economic Review*, 104:3565–3599, 2014.

Further Reading.

- Attila Ambrus, Yuhta Ishii, and James Burns. Gradual bidding in eBay-like auctions. Economic Research Initiatives at Duke (ERID) Working Paper No. 129, 2013.
- Rainer Böhme, Nicolas Christin, Benjamin Edelman, and Tyler Moore. Bitcoin: Economics, technology, and governance. *Journal of Economic Perspectives*, 29:213–238, 2015.
- John W. Byers, Michael Mitzenmacher, and Georgios Zervas. Information asymmetries in pay-per-bid auctions. In *Proceedings of the 11th ACM conference on Electronic Commerce*, pages 1–12. ACM, 2010.
- Michael Dinerstein, Liran Einav, Jonathan Levin, and Neel Sundaresan. Consumer price search and platform design in Internet commerce. NBER Working Paper No. 20415, 2014.
- Benjamin Edelman. Using Internet data for economic research. *Journal of Economic Perspectives*, 26:189–206, 2012.
- Benjamin Edelman and Julian Wright. Price coherence and adverse intermediation. *Quarterly Journal of Economics*, forthcoming.
- Glenn Ellison and Sara Fisher Ellison. Search, obfuscation, and price elasticities on the Internet. *Econometrica*, 77:427–452, 2009.
- Michael Luca. User-generated content and social media. In Simon Anderson, David Strömberg, and Joel Waldfogel, editors, *Handbook of Media Economics*. Elsevier, forthcoming.
- E. Glen Weyl. A price theory of multi-sided platforms. *American Economic Review*, 100:1642–1672, 2010.

Auctions in Practice – October 27, 2015.

(Featuring Jeff Siegel.)

For Class Discussion.

- Paul R. Milgrom. *Pricing and Auction Design With Complex Constraints*. 2015. Preliminary Draft.

Background.

- Paul Klemperer. Using and abusing auction theory. In Nir Vulkan, Alvin E. Roth, and Zvika Neeman, editors, *The Handbook of Market Design*, pages 62–89. Oxford University Press, 2013.
- FCC Staff. The broadcast television spectrum incentive auction: Innovation in policy to ignite innovation for consumers and business, 2013.
- Paul Milgrom, Lawrence Ausubel, Jonathan Levin, and Ilya Segal. Incentive auction rules option and discussion. Appendix to the FCC’s 28-Sep-2012 NPRM on Incentive Auctions, 2012.
- Gregory Rosston. Incentive auctions. *Communications of the ACM*, 55:24–26, 2012.
- Scott Duke Kominers and E. Glen Weyl. Holdout in the assembly of complements: A problem for market design. *American Economic Review Papers & Proceedings*, 102:360–365, 2012.

Further Reading.

- John Asker. A study of the internal organization of a bidding cartel. *American Economic Review*, 100:724–762, 2010.
- Susan Athey and Jonathan Levin. Information and competition in US Forest Service timber auctions. *Journal of Political Economy*, 109:375–417, 2001.
- Lawrence M. Ausubel and Paul Milgrom. The lovely but lonely Vickrey auction. In Peter Cramton, Yoav Shoham, and Richard Steinberg, editors, *Combinatorial Auctions*, pages 17–40. MIT Press, 2006.
- Nikhil Agarwal, Susan Athey, and David Yang. Skewed bidding in pay-per-action auctions for online advertising. *American Economic Review*, 99:441–47, 2009.
- Yeon-Koo Che, Phil Haile, and Michael Kearns. Design of the FCC incentive auctions. White Paper, 2013.
- Peter Cramton. The FCC spectrum auctions: An early assessment. *Journal of Economics & Management Strategy*, 6:431–495, 1997.
- Robert Day and Paul R. Milgrom. Core-selecting auctions. *International Journal of Game Theory*, 36:393–407, 2008.
- Ali Hortaçsu and David McAdams. Empirical work on auctions of multiple objects. *Journal of Economic Literature*, forthcoming.
- Paul R. Milgrom and Ilya Segal. Deferred-acceptance auctions and radio spectrum reallocation. Stanford University Working Paper, 2015.

Organ Allocation – November 3, 2015.

(Featuring Carmen Wang.)

For Class Discussion.

- Itai Ashlagi, David Gamarnik, Michael Rees, and Alvin E. Roth. The need for (long) chains in kidney exchange. NBER Working Paper No. 18202, 2012.
- Mohammad Akbarpour, Shengwu Li, and Shayan Oveis Gharan. Dynamic matching market design. Stanford University Working Paper, 2015.
- Robert Slonim, Carmen Wang, and Ellen Garbarino. The market for blood. *Journal of Economic Perspectives*, 28:177–96, 2014.

Background.

- Alvin E. Roth, Tayfun Sönmez, and M. Utku Ünver. Kidney exchange. *Quarterly Journal of Economics*, 119:457–488, 2004.
- Alvin E. Roth, Tayfun Sönmez, and M. Utku Ünver. Efficient kidney exchange: Coincidence of wants in markets with compatibility-based preferences. *American Economic Review*, 97:828–851, 2007.
- Itai Ashlagi and Alvin E. Roth. New challenges in multihospital kidney exchange. *American Economic Review*, 102:354–359, 2012.
- Gary S. Becker, Julio J. Elias, and Karen Ye. The shortage of kidneys for transplant: Altruism, exchanges, opt in versus opt out, and the market for kidneys. Becker Friedman Institute Working Paper, 2013.

Further Reading.

- Atila Abdulkadiroğlu and Tayfun Sönmez. House allocation with existing tenants. *Journal of Economic Theory*, 88:233–260, 1999.
- Itai Ashlagi and Alvin E. Roth. Free riding and participation in large scale, multi-hospital kidney exchange. *Theoretical Economics*, forthcoming.
- Haluk Ergin, Tayfun Sönmez, and M. Utku Ünver. Lung exchange. Boston College Working Paper, 2014.
- Judd B. Kessler and Alvin E. Roth. Don't take 'no' for an answer: An experiment with actual organ donor registrations. NBER Working Paper No. 20378, 2014.

Stephen Leider and Alvin E. Roth. Kidneys for sale: Who disapproves, and why? *American Journal of Transplantation*, 10:1221–1227, 2010.

Alvin E. Roth, Tayfun Sönmez, and M. Utku Ünver. A kidney exchange clearinghouse in New England. *American Economic Review*, 95:376–380, 2005.

Tayfun Sönmez and M. Utku Ünver. Market design for kidney exchange. In Nir Vulkan, Alvin E. Roth, and Zvika Neeman, editors, *The Handbook of Market Design*, pages 93–137. Oxford University Press, 2013.

Dynamic Allocation – November 10, 2015.

(Featuring Neil Thakral & Utku Ünver.)

For Class Discussion.

Vincent W. Slauch, Mustafa Akan, Onur Kesten, and M. Utku Ünver. The Pennsylvania adoption exchange improves its matching process. Boston College Working Paper, 2014.

Neil Thakral. Matching with stochastic arrival. Harvard University Working Paper, 2015.

Background.

M. Utku Ünver. Dynamic kidney exchange. *Review of Economic Studies*, 77:372–414, 2010.

Jacob Leshno. Dynamic matching in overloaded systems. Harvard University Working Paper, 2015.

Further Reading.

Susan Athey and Ilya Segal. An efficient dynamic mechanism. *Econometrica*, 81:2463–2485, 2013.

Mariagiovanna Baccara, SangMok Lee, and Leeat Yariv. Optimal dynamic matching. University of Pennsylvania Working Paper, 2015.

Onur Kesten and M. Utku Ünver. A theory of school-choice lotteries. *Theoretical Economics*, forthcoming.

Alessandro Pavan, Ilya Segal, and Juuso Toikka. Dynamic mechanism design: A Myersonian approach. *Econometrica*, 82:601–653, 2014.

James Schummer and Rakesh V. Vohra. Assignment of arrival slots. *American Economic Journal: Microeconomics*, 5:164–185, 2013.

Markets for Intellectual Property – November 17, 2015.

For Class Discussion.

Lauren Cohen, Umit G. Gurun, and Scott Duke Kominers. Patent trolls: Evidence from targeted firms. NBER Working Paper No. 20322, 2015.

Background.

Andrei Hagiu and David B. Yoffie. The new patent intermediaries: Platforms, defensive aggregators, and super-aggregators. *Journal of Economic Perspectives*, 27:45–65, 2013.

Joshua S. Gans and Scott Stern. Designing markets for ideas. In Nir Vulkan, Alvin E. Roth, and Zvika Neeman, editors, *The Handbook of Market Design*, pages 222–248. Oxford University Press, 2013.

Robin Feldman and Mark A. Lemley. Does patent licensing mean innovation? Stanford University Working Paper, 2015.

Eric Budish, Benjamin N. Roin, and Heidi L. Williams. Do firms underinvest in long-term research? Evidence from cancer clinical trials. *American Economic Review*, 105:2044–2085, 2015.

Michele Boldrin and David K. Levine. The case against patents. *Journal of Economic Perspectives*, 27:3–22, 2013.

Colleen Chien. Why it's time to open up our patent system. *The Washington Post*, June 30, 2015.

Michael Kremer. Patent buyouts: A mechanism for encouraging innovation. *Quarterly Journal of Economics*, 113:1137–1167, 1998.

Timo Fischer and Jan Leidinger. Testing patent value indicators on directly observed patent value – an empirical analysis of Ocean Tomo patent auctions. *Research Policy*, 43:519–529, 2014.

Further Reading.

Philippe Aghion, Peter Howitt, and Susanne Prantl. Revisiting the relationship between competition, patenting, and innovation. In Daron Acemoglu, Manuel Arellano, and Eddie Dekel, editors, *Advances in Economics and Econometrics, Tenth World Congress*, volume 1, pages 451–455. Cambridge University Press, 2013.

James E. Bessen, Michael J. Meurer, and Jennifer Ford. The private and social costs of patent trolls. *Regulation*, 34:26–35, 2011.

Christopher A. Cotropia, Jay P. Kesan, and David L. Schwartz. Unpacking patent assertion entities (PAEs). *Minnesota Law Review*, 99:649–703, 2014.

Alberto Galasso and Mark Schankerman. Patent thickets, courts, and the market for innovation. *RAND Journal of Economics*, 41:472–503, 2010.

Hugo Hopenhayn, Gerard Llobet, and Matthew Mitchell. Mechanisms for allocation and decentralization of patent rights. In Daron Acemoglu, Manuel Arellano, and Eddie Dekel, editors, *Advances in Economics and Econometrics, Tenth World Congress*, volume 1, pages 456–486. Cambridge University Press, 2013.

Josh Lerner and Jean Tirole. The economics of technology sharing: Open source and beyond. *Journal of Economic Perspectives*, 19:99–120, 2005.

Josh Lerner and Jean Tirole. Standard essential patents. *Journal of Political Economy*, forthcoming.

Catherine E. Tucker. Patent trolls and technology diffusion: The case of medical imaging. 2014. MIT Working Paper.

Heidi L. Williams. Intellectual property rights and innovation: Evidence from health care markets. In Josh Lerner and Scott Stern, editors, *Innovation Policy and the Economy*, volume 16. University of Chicago Press, 2015.

New Horizons – November 24, 2015.

(Featuring Helen Jack, Mike Luca, David Parkes, Ben Roth, & Ran Shorrer.)

Association of American Medical Colleges. FACTS: Applicants, matriculants, enrollment, graduates, M.D.-Ph.D., and residency applicants data, 2015. <https://www.aamc.org/data/facts/>.

Benjamin G. Edelman, Michael Luca, and Dan Svirsky. Racial discrimination in the sharing economy: Evidence from a field experiment. Harvard Business School NOM Unit Working Paper #16-069, 2016.

David C. Parkes, Christopher Thorpe, and Wei Li. Achieving trust without disclosure: Dark pools and a role for secrecy-preserving verification. In *Proceedings of the Third Conference on Auctions, Market Mechanisms and Their Applications*, forthcoming.

Erica Field, Rohini Pande, John Papp, and Natalia Rigol. Does the classic microfinance model discourage entrepreneurship among the poor? Experimental evidence from India. *American Economic Review*, 103:2196–2226, 2013.

Avinatan Hassidim, Assaf Romm, and Ran I. Shorrer. “Strategic” behavior in a strategy-proof environment. Harvard University Working Paper, 2016.

Student Talks/Course Wrap – December 1, 2015.

Scott Duke Kominers. A decade of design – A review of *The Handbook of Market Design* edited by Vulkan, Roth, and Neeman. *Journal of Economic Literature*, in preparation.

General References

Matching.

Alvin E. Roth and Marilda Sotomayor. *Two-sided matching: A study in game-theoretic modeling and analysis*. Cambridge University Press, 1990.

Royal Swedish Academy of Sciences. Scientific background: Stable allocations and the practice of market design, 2012.

Tayfun Sönmez and M. Utku Ünver. Matching, allocation, and exchange of discrete resources. *Handbook of Social Economics*, 1:781–852, 2009.

Auctions.

Peter Cramton, Yoav Shoham, and Richard Steinberg, editors. *Combinatorial Auctions*. MIT Press, 2006.

Paul Klemperer. *Auctions: Theory and Practice*. Princeton University Press, 2004.

Vijay Krishna. *Auction Theory*. Academic press, 2nd edition, 2009.

Paul Milgrom. *Putting Auction Theory to Work*. Cambridge University Press, 2004.

Market Design.

Alvin E. Roth. The art of designing markets. *Harvard Business Review*, 85:118–126, 2007.

Alvin E. Roth. What have we learned from market design? In Nir Vulkan, Alvin E. Roth, and Zvika Neeman, editors, *The Handbook of Market Design*, pages 7–50. Oxford University Press, 2013.

Related Areas

Search/Decentralized Matching.

Richard Rogerson, Robert Shimer, and Randall Wright. Search-theoretic models of the labor market: A survey. *Journal of Economic Literature*, 43:959–988, 2005.

Stephan Laueremann and Georg Nöldeke. Stable marriages and search frictions. *Journal of Economic Theory*, 151:163–195, 2014.

Algorithmic Game Theory.

Noam Nisan, Tim Roughgarden, Eva Tardos, and Vijay V. Vazirani, editors. *Algorithmic Game Theory*. Cambridge University Press, 2007.

Miscellany

Interesting Properties of the Course Number.

- The course number is a “safe prime” – that is, 2099 is prime and $(2099 - 1)/2 = 1049$ is also prime.
- The binary representation of the course number (100000110011) is also the decimal representation of a prime.
- The course number is the smallest prime that is the sum of 29 consecutive primes ($2099 = 13 + 17 + \dots + 139$).
- The course number is in the four-step Fibonacci sequence starting with 0, 1, 1, and 1.
- Assuming no changes in our calendar system, the year 2099 will have exactly three “Fridays the Thirteenth.” (So does 2015!)