

# Economics 2099 – Market Design (= HBS 4150)

Scott Duke Kominers

## Logistics

**Time.** Tuesdays, 16:00–18:45± $\epsilon$  (beginning September 5, 2017).

**Location.** Northwest Labs B103.

### Office Hours.

- By appointment – <https://2099-officehours.youcanbook.me/>.
- 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.)

### Course Webpage.

- [http://www.scottkom.com/courses/Market-Design\\_2017-2018/](http://www.scottkom.com/courses/Market-Design_2017-2018/)

### Teaching Assistant.

- Andrei Ciupan ([aciupan@hbs.edu](mailto:aciupan@hbs.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, 1080, and/or 2010a,b) and game theory (Economics 1052, 2052 and/or 2087hf) will provide useful context and technical background. Some understanding of algorithms, complexity, and/or combinatorics (e.g., Computer Science 121, 124, and/or 224, Math 152, and/or Applied Math 107) will at times be useful. Courses at the intersection of economics and computation (e.g., Computer Science 136, 234, and/or 236r) are highly complementary. 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 proposal summary/plan will be due on October 13, 2017. The final proposal will be due on December 8, 2017 (the last day of Reading Period).

**How to Read this Syllabus.** “Background” readings will be presented in class. Readings listed as “For Class Discussion” will be discussed intensively, and thus should be read in advance. (I will give specific advance reading guidance.) “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 5, 2017.

*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.

Scott Duke Kominers, Alexander Teytelboym, and Vincent P. Crawford. An invitation to market design. *Oxford Review of Economic Policy*, forthcoming.

*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.

Muriel Niederle and Alvin E. Roth. Unraveling reduces mobility in a labor market: Gastroenterology with and without a centralized match. *Journal of Political Economy*, 111:1342–1352, 2003.

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 12, 2017.

*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.

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

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

Eduardo M. Azevedo and Jacob D. Leshno. A supply and demand framework for two-sided matching markets. *Journal of Political Economy*, 124:1235–1268, 2016.

- Alexander S. Kelso and Vincent P. Crawford. Job matching, coalition formation, and gross substitutes. *Econometrica*, 50:1483–1504, 1982.
- Paul Milgrom. Simplified mechanisms with an application to sponsored-search auctions. *Games and Economic Behavior*, 70:62–70, 2010.
- Tayfun Sönmez and Tobias B. Switzer. Matching with (branch-of-choice) contracts at United States Military Academy. *Econometrica*, 81:451–488, 2013.
- Ravi Jagadeesan. Cadet-branch matching in a Kelso–Crawford economy. Harvard University Working Paper, 2016.
- Jonathan M. V. Davis and B. Pablo Montagnes. Designing organizational versus public markets. University of Chicago Working Paper, 2016.
- Benjamin N. Roth and Ran I. Shorrer. Making it safe to use centralized markets: Dominant individual rationality and applications to market design. MIT Working Paper, 2017.
- Avinatan Hassidim, Ran I. Shorrer, and Assaf Romm. “Strategic” players in a strategy-proof environment. Hebrew University Working Paper, 2015.
- Avinatan Hassidim, Déborah Marciano, Assaf Romm, and Ran I. Shorrer. The mechanism is truthful, why aren’t you? *American Economic Review Papers & Proceedings*, 107:220–224, 2017.

*Further Reading.*

- Itai Ashlagi, Yash Kanoria, and Jacob D. Leshno. Unbalanced random matching markets: The stark effect of competition. *Journal of Political Economy*, 125:69–98, 2017.
- John William Hatfield and Fuhito Kojima. Substitutes and stability for matching with contracts. *Journal of Economic Theory*, 145:1704–1723, 2010.
- John William Hatfield, Fuhito Kojima, and Scott Duke Kominers. Strategy-proofness, investment efficiency, and marginal returns: An equivalence. Becker Friedman Institute Working Paper, 2017.
- John William Hatfield and Scott Duke Kominers. Contract design and stability in many-to-many matching. *Games and Economic Behavior*, 101:78–97, 2017.
- John William Hatfield and Scott Duke Kominers. Hidden substitutes. Harvard University Working Paper, 2015.
- John William Hatfield and Paul Milgrom. Matching with contracts. *American Economic Review*, 95:913–935, 2005.
- Ravi Jagadeesan. Complementary inputs and the existence of stable outcomes in large trading networks. Harvard University Working Paper, 2017.
- Yuichiro Kamada and Fuhito Kojima. Efficient matching under distributional constraints: Theory and applications. *American Economic Review*, 105:67–99, 2015.
- Michael Ostrovsky. Stability in supply chain networks. *American Economic Review*, 98:897–923, 2008.
- Tayfun Sönmez. Bidding for army career specialties: Improving the ROTC branching mechanism. *Journal of Political Economy*, 121:186–219, 2013.

**Food Supply, Scrip Systems, and Pseudo-Markets – September 19, 2017.**

*For Class Discussion.*

- Canice Prendergast. The allocation of food to food banks. Booth School of Business Working Paper, 2017.

*Background.*

- Joan Sweeney and Richard James Sweeney. Monetary theory and the great Capitol Hill Baby Sitting Co-op crisis: Comment. *Journal of Money, Credit and Banking*, 9:86–89, 1977.
- Ian A. Kash, Eric J. Friedman, and Joseph Y. Halpern. Optimizing scrip systems: crashes, altruists, hoarders, sybils and collusion. *Distributed Computing*, 25:335–357, 2012.
- Ian A. Kash, Eric J. Friedman, and Joseph Y. Halpern. An equilibrium analysis of scrip systems. *ACM Transactions on Economics and Computation*, 3:#13, 2015.
- Tayfun Sönmez and M Utku Ünver. Course bidding at business schools. *International Economic Review*, 51:99–123, 2010.
- 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*, 102:2237–2271, 2012.

*Further Reading.*

- Eduardo M. Azevedo, E. Glen Weyl, and Alexander White. Walrasian equilibrium in large, quasilinear markets. *Theoretical Economics*, 8:281–290, 2013.
- Anna Bogomolnaia and Hervé Moulin. A new solution to the random assignment problem. *Journal of Economic theory*, 100:295–328, 2001.
- Eric Budish, Yeon-Koo Che, Fuhito Kojima, and Paul Milgrom. Designing random allocation mechanisms: Theory and applications. *American Economic Review*, 103:585–623, 2013.
- Eric Budish and Judd B. Kessler. Bringing real market participants’ real preferences into the lab: An experiment that changed the course allocation mechanism at Wharton. NBER Working Paper No. 22448, 2016.
- Yinghua He, Antonio Miralles, Marek Pycia, and Jianye Yan. A pseudo-market approach to allocation with priorities. Toulouse School of Economics (TSE) Working Paper, 2015.
- Aanund Hylland and Richard Zeckhauser. The efficient allocation of individuals to positions. *Journal of Political economy*, 87:293–314, 1979.
- Andreu Mas-Colell. Indivisible commodities and general equilibrium theory. *Journal of Economic Theory*, 16:443–456, 1977.

**School Choice – September 26, 2017.**

(Featuring Parag Pathak.)

*For Class Discussion.*

- Yan Chen and Onur Kesten. Chinese college admissions and school choice reforms: Theory and experiments. Tepper School of Business Working Paper, 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.
- Atila Abdulkadiroğlu, Nikhil Agarwal, and Parag A. Pathak. The welfare effects of congestion in uncoordinated assignment: Evidence from the NYC HS match. *American Economic Review*, forthcoming.
- Atila Abdulkadiroğlu, Parag A. Pathak, and Alvin E. Roth. Strategyproofness versus efficiency in matching with indifference: Redesigning the NYC high school match. *American Economic Review*, 99:1954–1978, 2009.

- 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.
- Parag A. Pathak and Peng Shi. How well do structural demand models work? Counterfactual predictions in school choice. MIT Working Paper, 2017.

*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.
- Caterina Calsamiglia and Maia Güell. The illusion of school choice: Empirical evidence from Barcelona. CEPR Discussion Paper No. DP10011, 2014.
- Battal Doğan and M. Bumin Yenmez. Unified enrollment in school choice: How to improve student assignment in Chicago. Boston College Working Paper, 2017.
- Umut Dur, Scott Duke Kominers, Parag A. Pathak, and Tayfun Sönmez. Reserve design: Unintended consequences and the demise of Boston’s walk zones. *Journal of Political Economy*, forthcoming.
- Umut Dur, Parag A. Pathak, and Tayfun Sönmez. Explicit vs. statistical preferential treatment in affirmative action: Theory and evidence from Chicago’s exam schools. 2016.
- Federico Echenique and M. Bumin Yenmez. How to control controlled school choice. *American Economic Review*, 105:2679–2694, 2015.
- Roland G. Fryer, Jr. and Glenn C. Loury. Valuing diversity. *Journal of Political Economy*, 121:747–774, 2013.
- John William Hatfield, Fuhito Kojima, and Yusuke Narita. Improving schools through school choice: A market design approach. *Journal of Economic Theory*, 166:186–211, 2016.
- Onur Kesten and M. Utku Ünver. A theory of school-choice lotteries. *Theoretical Economics*, 10:543–595, 2015.
- Scott Duke Kominers and Tayfun Sönmez. Matching with slot-specific priorities: Theory. *Theoretical Economics*, 11:683–710, 2016.
- 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.
- Parag A Pathak. What really matters in designing school choice mechanisms. In Larry Samuelson, editor, *Advances in Economics and Econometrics, 11th World Congress of the Econometric Society*. forthcoming.
- Peng Shi. Guiding school-choice reform through novel applications of operations research. *Interfaces*, 45:117–132, 2015.

**Signaling in Matching Markets – October 3, 2017.**

*For Class Discussion.*

- Soohyung Lee and Muriel Niederle. Propose with a rose? Signaling in Internet dating markets. *Experimental Economics*, 18:731–755, 2015.

*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.

**Internet Markets – October 10, 2017.**

(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*, 7:1–23, 2015.
- Andrey Fradkin. Search, matching, and the role of digital marketplace design in enabling trade: Evidence from Airbnb. MIT Working Paper, 2017.

*Background.*

- 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 of the Econometric Society*, volume 1, pages 48–75. Cambridge University Press, 2013.
- Andrey Fradkin. The economics of platforms (with Greg Lewis). *Economic Frontiers [Podcast]*, 2015.
- Thomas Eisenmann, Geoffrey Parker, and Marshall W. Van Alstyne. Strategies for two-sided markets. *Harvard Business Review*, 84(10):92–101, 2006.
- 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. Assessing sales strategies in online markets using matched listings. *American Economic Journal: Microeconomics*, 7:215–247, 2015.
- 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, 2016.
- 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.
- Avi Goldfarb and Catherine Tucker. Inequality, privacy and digital market design. In Scott Duke Kominers and Alexander Teytelboym, editors, *Fair by Design: Economic Design Responses to Inequality*. Oxford University Press, forthcoming.
- Andrey Fradkin. Digital market design and inequality. In Scott Duke Kominers and Alexander Teytelboym, editors, *Fair by Design: Economic Design Responses to Inequality*. Oxford University Press, forthcoming.

*Further Reading.*

- Susan Athey. Information, privacy, and the Internet: An economic perspective, 2014. CPB Netherlands Bureau for Economic Policy Analysis.
- Jörn Boehnke. Recovery from bidding fever: Why pay more than 102% to buy a gift card? Harvard University Working Paper, 2015.
- Rainer Böhme, Nicolas Christin, Benjamin Edelman, and Tyler Moore. Bitcoin: Economics, technology, and governance. *Journal of Economic Perspectives*, 29:213–238, 2015.
- 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, Michael Luca, and Dan Svirsky. Racial discrimination in the sharing economy: Evidence from a field experiment. *American Economic Journal: Applied Economics*, 9:1–22, 2017.
- Glenn Ellison and Sara Fisher Ellison. Search, obfuscation, and price elasticities on the Internet. *Econometrica*, 77:427–452, 2009.
- Avi Goldfarb and Catherine E. Tucker. Privacy regulation and online advertising. *Management Science*, 57:57–71, 2011.
- 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.
- E. Glen Weyl. A price theory of multi-sided platforms. *American Economic Review*, 100:1642–1672, 2010.

**Auction Theory – October 17, 2017.**

(Featuring Shengwu Li.)

*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.

*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.
- Roger B. Myerson and Mark A. Satterthwaite. Efficient mechanisms for bilateral trading. *Journal of Economic Theory*, 29:265–281, 1983.
- 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.
- Michael Ostrovsky and Michael Schwarz. Reserve prices in Internet advertising auctions: A field experiment. Stanford Graduate School of Business Working Paper, 2016.
- Shengwu Li. Obviously strategy-proof mechanisms. *American Economic Review*, forthcoming.

*Further Reading.*

- Nikhil Agarwal, Susan Athey, and David Yang. Skewed bidding in pay-per-action auctions for online advertising. *American Economic Review*, 99:441–447, 2009.
- 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.
- 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.
- Paul R. Milgrom and Robert J. Weber. A theory of auctions and competitive bidding. *Econometrica*, 50:1089–1122, 1982.
- 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.

**The US Spectrum Incentive Auction – October 24, 2017.**

(Featuring Nazar Batih and Mariko Cantley.)

*For Class Discussion.*

- Kevin Leyton-Brown, Paul Milgrom, and Ilya Segal. Economics and computer science of a radio spectrum reallocation. *Proceedings of the National Academy of Sciences*, 114:7202–7209, 2017.

*Background.*

- FCC Staff. The broadcast television spectrum incentive auction: Innovation in policy to ignite innovation for consumers and business, 2013.
- Scott Duke Kominers. To improve wireless networks, auction the airwaves. *Bloomberg View*, July 24, 2017.
- Paul Milgrom. *Discovering Prices: Auction Design in Markets with Complex Constraints*. Columbia University Press, 2017.
- 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.
- 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.*

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.

Robert Day and Paul R. Milgrom. Core-selecting auctions. *International Journal of Game Theory*, 36:393–407, 2008.

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.

Paul R. Milgrom and Ilya Segal. Deferred-acceptance auctions and radio spectrum reallocation. Stanford University Working Paper, 2017.

**Organ Allocation – October 31, 2017.**

(Featuring Carmen Wang.)

*For Class Discussion.*

Michael A. Rees, Ty B. Dunn, Christian S. Kuhr, Christopher L. Marsh, Jeffrey Rogers, Susan E. Rees, Alejandra Cicero, Laurie J. Reece, Alvin E. Roth, Obi Ekwenna, et al. Kidney exchange to overcome financial barriers to kidney transplantation. *American Journal of Transplantation*, 17:782–790, 2017.

A. C. Wiseman and J. S. Gill. Financial incompatibility and paired kidney exchange: Walking a tightrope or blazing a trail? *American Journal of Transplantation*, 17:597–598, 2017.

*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.

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

Itai Ashlagi and Alvin E. Roth. New challenges in multihospital kidney exchange. *American Economic Review*, 102:354–359, 2012.

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.

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.

Sandro Ambuehl. An offer you can’t refuse? Incentives change what we believe. Rotman School of Management Working Paper, 2016.

Robert Slonim, Carmen Wang, and Ellen Garbarino. The market for blood. *Journal of Economic Perspectives*, 28:177–96, 2014.

*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. 9:817–863, 2014.

- Haluk Ergin, Tayfun Sönmez, and M Utku Ünver. Dual-donor organ exchange. *Econometrica*, forthcoming.
- 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.
- Jacob Leshno. Dynamic matching in overloaded systems. Harvard University Working Paper, 2015.
- 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.
- Neil Thakral. Matching with stochastic arrival. Harvard University Working Paper, 2015.

### **Refugees, Immigration, and Economic Development – November 7, 2017.**

(Featuring Natalia Rigol and Ilya Vidrin.)

*Readings to be announced.*

### **Markets for Intellectual Property – November 14, 2017.**

*For Class Discussion.*

- Lauren Cohen, Umit G. Gurun, and Scott Duke Kominers. Patent trolls: Evidence from targeted firms. NBER Working Paper No. 20322, 2017.
- Scott Duke Kominers. One thing you don't need is stronger patents. *Bloomberg View*, July 6, 2017.

*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. Do patent licensing demands mean innovation? *Iowa Law Review*, 101:137–189, 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.
- Lauren Cohen, John M. Golden, Umit G. Gurun, and Scott Duke Kominers. 'Troll' check? A proposal for administrative review of patent litigation. *Boston University Law Review*, forthcoming.

*Further Reading.*

- 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.
- Gaétan De Rassenfosse, Adam B. Jaffe, and Elizabeth Webster. Low-quality patents in the eye of the beholder: Evidence from multiple examiners. NBER Working Paper No. 22244, 2016.
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**New Horizons – November 21, 2017.**

(Featuring Ravi Jagadeesan, Nikhil Naik, David Parkes, Ben Roth, & Utku Ünver.)

*Readings to be announced.*

**Student Talks/Course Wrap – November 28, 2017.**

*Readings to be announced.*

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## **Related Areas**

### **Matching in Trading Networks.**

- Eduardo M. Azevedo and John William Hatfield. Existence of stable matchings in large markets with complementarities. University of Texas at Austin Working Paper, 2015.
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### **Search/Decentralized Matching.**

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### **Algorithmic Game Theory.**

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## **Miscellany**

### **Food for Thought.**

- Daniel Quinn. *Ishmael: A Novel*. Bantam, 1992.

### **A Useful Book.**

- David Allen. *Getting Things Done: The Art of Stress-Free Productivity*. Penguin, 2015.

### Interesting Properties of the Course Number(s).

- 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.”
- The HBS cross-listing number is the first “5-powerful number” – that is, 4150 is the smallest number that is the sum of the fifth powers of its digits ( $4150 = 1024 + 1 + 3125 + 0 = 4^5 + 1^5 + 5^5 + 0^5$ ).
- The HBS cross-listing number is the smallest integer  $k$  such that  $\frac{50!+k}{50}$  is prime.
- The HBS cross-listing number is a Rothian number.
- The HBS cross-listing number satisfies a Spironacci-style recurrence.