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Education

B.A. Mathematics cum laude, Princeton University, Aug. 2005 – June 2009.

Certificate in Finance, Princeton University, Aug. 2005 – June 2009.

Ph.D. Information Systems, NYU Stern School of Business, Aug. 2011 – Sept. 2015.

Dissertation: *Network Games with Incomplete Information Played by "Bayesian" Players*
Dissertation Committee: Roy Radner, Ilan Lobel, David Pearce

References

Professor Abhijit Banerjee
MIT Department of Economics
77 Massachusetts Avenue, E52-540
Cambridge, MA 02139
617-253-8855
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Professor Benjamin Golub
Harvard University Department of Economics
Littauer Center, Rm 308
Cambridge, MA 02138
617-496-0009
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Professor David Pearce
NYU Department of Economics
19 W 4th Street, 6th Floor
New York, NY 10012
212-992-8779
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Professor Ilan Lobel
NYU Stern School of Business
Department of Information, Operations, and Management Sciences
44 West 4th St, 8-71
New York, NY 10012
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Fields

Primary Fields: Theory, Economics of Networks

Secondary Fields: Economics of Innovation

Employment

Cornerstone Research, Analyst, Aug. 2009 – Aug. 2011.

Microsoft Research, Intern, Jun. 2014 – Aug. 2014.

Harvard University and Massachusetts Institute of Technology, July 2015 – Present.

Prize Fellow in Economics, History, and Politics, Harvard
Postdoctoral Fellow, Abdul Latif Jameel Poverty Action Lab, MIT

Research

Journal Publications

Customer Referral Incentives and Social Media, I. Lobel, E. Sadler, and L. Varshney, *Management Science* 63(10), 3514–3529, 2017.

We study how to optimally attract new customers using a referral program. Whenever a consumer makes a purchase, the firm gives her a link to share with friends, and every purchase coming through that link generates a referral payment. The firm chooses the referral payment function and consumers play an equilibrium in response. The optimal payment function is nonlinear and not necessarily monotonic in the number of successful referrals. If we approximate the optimal policy using a linear payment function, the approximation loss scales with the square root of the average consumer degree. Using a threshold payment, the approximation loss scales proportionally to the average consumer degree. Combining the two, using a linear payment function with a threshold bonus, we can achieve a constant bound on the approximation loss.

Preferences, Homophily, and Social Learning, I. Lobel and E. Sadler, *Operations Research* 64(3), 564–584, 2016.

We study sequential Bayesian social learning in networks in which agents have heterogeneous preferences, and neighbors tend to have similar preferences—a phenomenon known as homophily. We find that the density of network connections determines the impact of preference diversity and homophily on learning. When connections are sparse, diverse preferences are harmful to learning, and homophily may lead to substantial improvements. In contrast, in a dense network, preference diversity is beneficial. Intuitively, diverse ties introduce more independence between observations while providing less information individually. Homophilous connections individually carry more useful information, but multiple observations become redundant.

Information Diffusion in Networks Through Social Learning, I. Lobel and E. Sadler, *Theoretical Economics* 10(3), 807–851, 2015.

In a sequential social learning model, we ask how the network structure affects agents' ability to transmit and aggregate dispersed information. In contrast with prior work, we do not assume that the agents' sets of neighbors are mutually independent. We introduce a new metric of information diffusion in social learning, which is weaker than the traditional aggregation metric. We show that if a minimal connectivity condition holds and neighborhoods are independent, information always diffuses. Diffusion can fail in a well-connected network if neighborhoods are correlated. Information diffuses if neighborhood realizations convey little information about the network, as measured by network distortion, or if information asymmetries are captured through beliefs over the state of a finite Markov chain.

Minimax and the Value of Information, E. Sadler, *Theory and Decision* 78(4), 575–586, 2015.

In his discussion of minimax decision rules, Savage (1954, p. 170) presents an example purporting to show that minimax applied to negative expected utility (referred to by Savage as "negative income") is an inadequate decision criterion for statistics; he suggests the application of a minimax regret rule instead. The crux of Savage's objection is the possibility that a decision maker would choose to ignore even "extensive" information. More recently, Parmigiani (1992) has suggested that minimax regret suffers from the same flaw. He demonstrates the existence of "relevant" experiments that a minimax regret agent would never pay a positive cost to observe. On closer inspection, I find that minimax regret is more resilient to this critique than would first appear. In particular, there are cases in which no experiment has any value to an agent employing the minimax negative income rule, while we may always devise a hypothetical experiment for which a minimax regret agent would pay. The force of Parmigiani's critique is further blunted by the observation that "relevant" experiments exist for which

a Bayesian agent would never pay. I conclude with a discussion of pessimism in the context of minimax decision rules.

Working Papers

Diffusion Games, 2017 (Job Market Paper).

Behaviors and information often spread via person-to-person diffusion. I argue that standard simplifying assumptions in diffusion models can lead to misguided predictions. A more detailed model has more realistic qualitative features, and we can reverse standard comparative statics results. We also uncover a new strategic effect: when large cascades are possible, exposure to the contagion conveys information about a player's network position. This information allows players to better coordinate their actions. The analysis requires technical advances in the study of random graphs, and a key contribution is a pair of limit theorems for a multi-type configuration model.

Dead Ends, 2017.

Evidence suggests that innovation benefits from low-powered incentives, yet innovative organizations use widely varying incentive structures. I offer an explanation based on a characteristic feature of creative work: dead ends. To solve a problem, an agent works on successive ideas, each of which may succeed with some probability. At each instant, the agent chooses whether to exert effort. The agent may also abandon his idea, incurring delay to come up with a new one. High rewards for success can slow innovation because the agent is reluctant to incur the cost of delay, spending too much time on unpromising ideas. I apply this framework to study intellectual property rights and optimal contracts for innovation. Dead ends provide a new explanation for the inverse U relationship between IPR and innovation, suggesting that "low-hanging fruit" suffers most from strong IPR. In a principal-agent setting with moral hazard, we get front-loading because high continuation values increase the cost of current incentives. Contract structure depends on whether the principal is more or less patient than the agent. Impatient principals impose deadlines, while patient principals grant tenure, using delay rather than the threat of termination to reduce incentive costs.

Peer-Confirming Equilibrium (with E. Lipnowski), 2017 (*Revise and Resubmit, Econometrica*).

We can often predict the behavior of those closest to us more accurately than that of complete strangers, yet we routinely engage in strategic situations with both: our social network impacts our strategic knowledge. Peer-confirming equilibrium describes the behavioral consequences of this intuition in a noncooperative game. We augment a game with a network to represent strategic information: if two players are linked in the network, they have correct conjectures about each others' strategies. In peer-confirming equilibrium, there is common belief that players (i) behave rationally and (ii) correctly anticipate neighbors' play. In simultaneous-move games, adding links to the network always restricts the set of outcomes. In dynamic games, the outcome set may vary non-monotonically with the network because the actions of well-connected players help poorly-connected players coordinate. This solution concept provides a useful language for studying public good provision, highlights a new channel through which central individuals facilitate coordination, and delineates possible sources of miscoordination in protests and coups.

Resource Allocation with Positive Externalities (with D. Bhaskar), 2017.

In several common allocation problems, transfers are unavailable, but incentives are partially aligned because the allocation to one player entails positive, though imperfect, externalities to the other. We study the extent to which a designer can exploit this alignment when allocating a budget between two players. We identify a natural mechanism, the infinite hierarchical mechanism, which partitions the type space into a countably infinite set of intervals and allocates the budget to the player

in the highest interval. If both players are in the same interval, it divides the budget evenly. An appealing feature is that a designer can implement this mechanism without commitment power, and the mechanism is optimal among those implementable without commitment. Our main result shows that this mechanism remains optimal with full commitment power if the hazard rate of the type distribution is monotone, and the density is either increasing or decreasing.

Innovation Adoption and Collective Experimentation, 2017.

I study social learning about an innovation when individuals gather costly information and share their knowledge through social ties. The structure of the social network and the distribution of initial beliefs jointly determine long-run adoption behavior in the population. Networks that share information efficiently converge on a decision more quickly but are more prone to errors. Consequently, dense or centralized networks can have more volatile outcomes in the long run, and efforts to seed adoption in the network should focus on individuals who are disconnected from one another. I argue that anti-seeding, preventing central individuals from experimenting early in the learning process, can be an effective intervention to encourage adoption because the population as a whole may gather more information.

Work in Progress

Peer Effects in Endogenous Networks (with B. Golub)

Policymakers often consider changing the composition of peer groups in the presence of peer effects in order to improve outcomes in education, production, and other settings. An important feature of such environments is that agents' decisions determine which peer effects operate. For instance, students in school choose not only how much effort to exert, but also with whom to collaborate and how intensively. We build a model in which productive and collaborative (network formation) efforts are strategic complements, with an arbitrary number of types. The model has a closed-form solution yielding interpretable formulas related to classic network centrality measures. We use the model for three purposes: (i) explaining why empirical strategies neglecting endogenous network formation effort can be misleading; (ii) detailing, via calibrations, unintended consequences of group composition designs that neglect endogenous formation effort; (iii) discussing optimal group composition that takes network formation into account.

False Information and Disagreement

Disagreement, including on matters of fact, is a pervasive phenomenon, yet this is incompatible with existing models of social learning. I propose a new model of information processing with two key features: (i) the agent encounters false information, and (ii) the agent cannot distinguish true propositions from false ones. I study two families of axioms for update rules in this environment, finding that "willingness-to-learn" axioms are incompatible with "non-manipulability" axioms. I also provide an axiomatic characterization of update rules capturing skepticism, wishful thinking, and confirmation bias. In a simple social learning model, disagreement is not just possible, but generic. In an arbitrary network, I characterize the influence that each agent has on steady state beliefs, and I explore interventions a planner might make to improve learning outcomes.

Other Publications

Learning in Social Networks (with B. Golub), *Oxford Handbook on the Economics of Networks* (edited by Y. Bramoullé, A. Galeotti, and B. Rogers), 2016.

Professional Activities

Referee for *Econometrica, Review of Economic Studies, Quarterly Journal of Economics, Journal of the European Economic Association, Nature, Proceedings of the National Academy of Sciences, Theoretical Economics, American Economic Journal: Microeconomics, Games and Economic Behavior, Economic Theory, Operations Research, IEEE Transactions on Automatic Control, Scottish Journal of Political Economy, Journal of Mathematical Sociology, The Economic Journal, Theory and Decision*

Reviewer for NSF grants

Organizer, Retreat on Information, Networks, and Social Economics (RINSE), Oceanside, CA, August 2017.

Invited Talks

July 2014; IESE Business School Workshop on Learning in Social Networks; IESE Business School.

August 2016; Workshop on Information and Social Economics; California Institute of Technology.

March 2018; Roy-Adres Seminar in Economic Theory; Paris School of Economics.

Conference Presentations

July 2012; Stony Brook Game Theory Conference; SUNY Stony Brook.

September 2012; Workshop on Information in Networks; NYU Stern School of Business.

October 2012; INFORMS Annual Meeting; Phoenix, AZ.

November 2012; Workshop on Information and Decision in Social Networks; Massachusetts Institute of Technology.

June 2013; ACM Conference on Electronic Commerce (EC); Philadelphia, PA.

October 2013; Workshop on Information in Networks; NYU Stern School of Business.

October 2013; INFORMS Annual Meeting; Minneapolis, MN.

November 2014; INFORMS Annual Meeting; San Francisco, CA.

December 2014; European Winter Meeting of the Econometric Society; Madrid, Spain.

May 2015; Conference on Information Transmission in Networks; Harvard University.

October 2015; Workshop on Information in Networks; NYU Stern School of Business.

December 2015; European Winter Meeting of the Econometric Society; Milan, Italy.

April 2016; Conference on Network Science in Economics; Stanford University.

June 2016; North American Summer Meeting of the Econometric Society; Philadelphia, PA.

January 2017; ASSA Meetings; Chicago, IL.

April 2017; Conference on Network Science in Economics; Washington University.

June 2017; North American Summer Meeting of the Econometric Society; St. Louis, MO.

November 2017; NSF/NBER/CEME Theory Conference; University of Texas, Austin.

December 2017; European Winter Meeting of the Econometric Society; Barcelona, Spain.

Awards and Honors

Harvard University Prize Fellowship in Economics, History, and Politics (2015)

NET Institute Summer Grant Award (2013)

Years 1–4 NYU Stern PhD. Director's Fellowship (2011)

Elected to Sigma Xi (2009)

National Merit Scholar (2005)

USA Math Talent Search, Gold Prize (2003, 2004)

USA Mathematical Olympiad, Qualifier (2002, 2003, 2004, 2005)

Teaching Experience

Spring 2017, Guest Lecture for Networks (PhD), Harvard

Summer 2015, Lecturer for Information Technology in Business and Society (Undergraduate), NYU Stern.

Fall 2014, TA for Information Technology in Business and Society (Undergraduate), NYU Stern.

Spring 2014, TA for Information Technology in Business and Society (Undergraduate), NYU Stern.

Summer 2013, TA for Prediction (MBA), NYU Stern.

Spring 2013, TA for Trading Strategies and Systems (MBA), NYU Stern.

Spring 2012, TA for Data Mining for Business Analytics (MBA), NYU Stern.

Personal

United States Citizen

Last updated: November 20, 2017