David A. Miller

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Tenure track appointment

- University of California, San Diego, Dept. of Economics: Assistant Professor, 2004–present

Other positions

- Yale University, Dept. of Economics: Visiting Professor, 2008–2009
- Tellus Institute, Risk Analysis Group, Boston, MA: Research Analyst, 1995–1998

Education

- Stanford University: Ph.D. in Economics, June 2004
  Dissertation committee: Susan Athey (primary advisor), Ilya Segal, Steven Tadelis
- Harvard University: A.B. in Environmental Science and Public Policy, June 1995
  Summa cum laude

Work in progress

- "Monitoring with collective memory: Forgiveness for optimally empty promises"
  With Kareen Rozen

  We study optimal contracting in a team setting with moral hazard, where teammates promise to complete socially efficient but costly tasks. Teammates must monitor each other to provide incentives, but each team member has limited capacity to allocate between monitoring and productive tasks. Players incur contractual punishments for unfulfilled promises that are discovered. We show that optimal contracts are generally "forgiving" and players optimally make "empty promises" that they don't necessarily intend to fulfill. As uncertainty in task completion increases, players optimally make more empty promises but fewer total promises. A principal who hires a team of agents optimally implements a similar contract, with profit-sharing and employment-at-will. When agents differ in their productivity, the model suggests a "Dilbert principle" of supervision: less productive players optimally specialize in monitoring the more productive players' promises.

- "A theory of disagreement in repeated games with bargaining"
  With Joel Watson

  This paper proposes a new equilibrium concept for repeated games with transferable utility, in which the players may negotiate cooperatively over their continuation strategies at the beginning of each period. In contrast to renegotiation proofness, a *contractual equilibrium* gives an explicit account of whether the players reach an agreement in a given period. Under disagreement, play may be jointly suboptimal. Under agreement, play is optimal in the continuation game, and the players split the surplus (according to fixed bargaining weights) relative to what they would have played under disagreement. Contractual equilibrium outcomes also arise as subgame perfect equilibria in a class of models with noncooperative bargaining, under several assumptions on the endogenous meaning of cheap talk messages. Contractual equilibria exist for all discount factors, and for any given discount factor all contractual equilibria attain the same aggregate utility. The paper provides necessary and sufficient conditions for patient players to attain efficiency, as well as simple sufficient conditions. The allocation of bargaining power can dramatically affect aggregate utility. The theory extends naturally to games with imperfect public monitoring.

- "Enforcing cooperation in networked societies"
  With S. Nageeb Ali

  We endogenize social network formation and collective enforcement using a model in which players interact bilaterally and repeatedly along costly links. Players observe only their own partners' actions, so collective punishments that support cooperation must spread endogenously through the network, as a contagion. Our model features asynchronous interaction, variable stakes in each relationship, and transferable utilities. With these properties, for any network there exists a contagion equilibrium in which incentive constraints bind along the equilibrium path. Among symmetric networks, the optimal network topology in a large society features many identical, independent cliques. We conjecture that such a network is also Pareto optimal among all (symmetric and asymmetric) networks. Our results formalize the notion that when collective enforcement is decentralized, the level of social cooperation, or "social capital," is maximized in tight-knit, highly clustered groups.

- "A contract-theoretic model of conservation agreements"
  With Heidi Gjertsen, Theodore Groves, Eduard Niesten, Dale Squires, and Joel Watson

  We model conservation agreements using *contractual equilibrium*, a concept introduced by Miller and Watson (2010) to model dynamic relationships with renegotiation. The setting takes the form of a repeated principal-agent problem, where the principal must pay to observe a noisy signal of the agent's effort. Lacking a strong external enforcement system, the parties rely on self-enforcement for their relational contract. We characterize equilibrium play (including how punishments and rewards are structured) and we show how the parties' relative bargaining powers affect their ability to sustain cooperation over time. We argue that the model captures important features of real conservation agreements and reveals the ingredients required for successful agreements.

- "Attainable payoffs in repeated games with interdependent private information"

  This paper proves folk theorems for repeated games with private information, communication, and monetary transfers, in which signal spaces may be arbitrary, signals may be statistically interdependent, and payoffs for each player may depend on the signals of other players.

Publications

- "Robust collusion with private information"

  Review of Economic Studies, accepted for publication.

  The game-theoretic literature on collusion has been hard pressed to explain why a cartel should engage in price wars, without resorting to either impatience, symmetry restrictions, inability to communicate, or failure to optimize. This paper introduces a new explanation that relies on none of these assumptions: if the cartel's member firms have private information about their costs, price wars can be optimal in the face of complexity. Specifically, equilibria that are robust to payoff-irrelevant disruptions of the information environment generically cannot attain or approximate efficiency. An optimal robust equilibrium must allocate market shares inefficiently, and may call for price wars under certain conditions. For a two-firm cartel, cost interdependence is a sufficient condition for price wars to arise in an optimal robust equilibrium. That optimal equilibria are inefficient generically applies not only to collusion games, but also to the entire *separable payoff environment* (Chung & Ely 2006)—a class that includes most typical economic models.

- "Invention under uncertainty and the threat of ex post entry"

  European Economic Review, 52(3):387–412, April 2008 (lead article).

  This paper proposes a theoretical framework for studying the invention of new products when demand is uncertain. In this framework, under general conditions, the threat of ex post entry by a competitor can deter invention ex ante. Asymmetric market power in the ex post market exacerbates the problem. The implications of these general results are examined in a series of examples that represent important markets in the computer industry. The first is a model that shows how an operating system monopolist, by its mere presence, can deter the invention of complements, to its own detriment as well as that of society. The implications of policies such as patent protection, price regulation, and mandatory divestiture are considered. Three additional examples consider the ability of a monopolist in one market to commit to bundling an unrelated product, a pair of horizontally differentiated firms that can add a new feature to their products, and a platform leader that can be challenged in its base market by the supplier of a complementary product.

- "Was there too little entry during the Dot Com Era?"
  With Brent Goldfarb and David Kirsch

  Journal of Financial Economics, 86(1):100–144, October 2007.

We present four stylized facts about the Dot Com Era: (1) there was a widespread belief in a "Get Big Fast" business strategy; (2) the increase and decrease in public and private equity investment was most prominent in the internet and information technology sectors; (3) the survival rate of dot com firms is on par or higher than other emerging industries; and (4) firm survival is independent of private equity funding. To connect these findings we offer a herding model that accommodates a divergence between the information and incentives of venture capitalists and their investors. A Get Big Fast belief cascade may have led to overly focused investment in too few internet startups and, as a result, too little entry.

Popular press coverage:

  - Lee Gomes, "The Dot-Com Bubble is reconsidered—and maybe relived," *The Wall Street Journal*, p. B1, November 8, 2006
  - Leslie Taylor, "The dot-com bust? Not as bad as you think," Inc.com, December 4, 2006, http://www.inc.com/criticalnews/articles/200612/bubble.html

- "Efficiency in repeated trade with hidden valuations"
  With Susan Athey

  Theoretical Economics, 2(3):299–354, September 2007.

  We analyze the extent to which efficient trade is possible in an ongoing relationship between impatient agents with hidden valuations (i.i.d. over time), restricting attention to equilibria that satisfy ex post incentive constraints in each period. With *ex ante* budget balance, efficient trade can be supported in each period if the discount factor is at least one half. In contrast, when the budget must balance *ex post*, efficiency is not attainable, and furthermore for a wide range of probability distributions over their valuations, the traders can do no better than employing a posted price mechanism in each period. Between these extremes, we consider a "bank" that allows the traders to accumulate budget imbalances over time, but only within a bounded range. We construct non-stationary equilibria that allow traders to receive payoffs that approach efficiency as their discount factor approaches one, while the bank earns exactly zero expected profits. For some probability distributions there exist equilibria that yield exactly efficient payoffs for the players and zero profits for the bank, but such equilibria require very high discount factors.

- "'Token' equilibria in sensor networks with multiple sponsors"
  With Sameer Tilak and Tony Fountain

  Proceedings of the Workshop on Stochasticity in Distributed Systems (StoDiS'05), San Jose, CA, December 19, 2005.

  When two sponsoring organizations, working towards separate goals, employ wireless sensor networks for a finite period of time, it can be efficiency-enhancing for the sponsors to program their sensors to cooperate. But if each sensor privately knows whether it can provide a favor in any particular period, and the sponsors cannot contract on ex post payments, then no favors are performed in

any Nash equilibrium. Allowing the sponsors to contract on ex post payments, we construct equilibria based on the exchange of "tokens" that yield significant cooperation and increase expected sponsor payoffs. Increasing the sponsors' liability is beneficial because it enables them to use more tokens.

Fellowships and Grants

- NET Institute Summer Grant, 2010
- Stanford Institute for Economic Policy Research Dissertation Fellowship, 2003–2004

Professional activity

- Member: American Economic Association, Econometric Society, Game Theory Society
- Referee: *Econometrica*, *American Economic Review*, *Review of Economic Studies*, *Theoretical Economics*, *Games and Economic Behavior*, *Journal of Economic Theory*, *RAND Journal of Economics*, *American Economic Journal: Microeconomics*, *Journal of the European Economic Association*, *Journal of Mathematical Economics*, *Economic Theory*, *International Economic Review*, *Journal of Economics and Management Strategy*, *Review of Economic Dynamics*, *Berkeley Journals in Theoretical Economics*, *Management Science*, *Journal of Industrial Economics*, and *International Journal of Industrial Organization*, NSF Economics Program, NSF Science of Science & Innovation Policy Program.
- Excellence in Refereeing Award 2011, *American Economic Review*

Presentations

- "Enforcing cooperation in networked societies"
  2011: Econometric Society North American Summer Meeting, Washington University, St. Louis. 2010: Southern California Symposium on Network Economics and Game Theory; NSF/CEME Decentralization Conference, Royal Irish Academy; Bocconi University; European University Institute. 2008: UCSD; Stanford Institute for Theoretical Economics; Annual Meeting of the Society for Economic Dynamics, MIT; Georgetown; USC Marshall; Harvard/MIT; NYU Stern; Yale.
- "Modeling market power with repeated games"
  2011: UCSD Osher Institute.
- "A theory of disagreement in repeated games with renegotiation"
  2011: Duke/Fuqua/UNC; Econometric Society North American Winter Meeting, Denver.

2010: Collegio Carlo Alberto; UC Riverside. 2009: NBER Organizational Economics Working Group Meeting, Cambridge, Massachusetts; UCSD. 2008: UCSD; UCLA; Southwest Economic Theory Conference, UCSB; USC; Third World Congress of the Game Theory Society, Kellogg School of Management; Workshop on Recent Advances in Repeated Games, Stony Brook Game Theory Festival; Columbia; Western Ontario; Toronto.

- "Monitoring with collective memory: Forgiveness for optimally empty promises"
  2010: Zurich. 2009: NSF/NBER/CEME Conference on General Equilibrium and Mathematical Economics, UCSD.

- "A short course on repeated games"
  2007: Sungkyunkwan University.

- "Efficiency in repeated trade with hidden valuations"
  2006: Australasian Meetings of the Econometric Society, Alice Springs, Australia; Arizona State. 2005: UCSD; NBER/NSF Decentralization Conference, University of Illinois at Urbana-Champaign.

- "Four lectures on repeated games with private information"
  2006: Shanghai University of Finance and Economics.

- "Optimal ex post incentive compatible equilibria in repeated games of private information"
  2006: University of Melbourne. 2005: Econometric Society World Congress, University College London; USC; UC Riverside; Caltech. 2004: UT Austin; UCSD; Northwestern; Kellogg School of Management; Michigan; Brown; Yale School of Management; Wisconsin; UCLA.

- "Was there too little entry during the Dot Com Era?"
  2006: UCSD.

- "'Token' equilibria in sensor networks with multiple sponsors"
  2005: Caltech SISL Workshop.

- "Invention under uncertainty and the threat of ex post entry"
  2005: International Industrial Organization Conference, Georgia Tech.

- "Attainable payoffs in repeated games with private information"
  2005: Southwest Economic Theory Conference, UC Riverside; Stanford Institute for Theoretical Economics. 2004: UCSD.

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