

# Jonathan Levin: 2011 John Bates Clark Medalist

Liran Einav and Steve Tadelis

**J**onathan Levin, the 2011 recipient of the American Economic Association's John Bates Clark Medal, has established himself as a leader in the fields of industrial organization and microeconomic theory. Jon has made important contributions in many areas: the economics of contracts and organizations; market design; markets with asymmetric information; and estimation methods for dynamic games. Jon's combination of breadth and depth is remarkable, ranging from important papers in very distinct areas such as economic theory and econometric methods to applied work that seamlessly integrates theory with data. In what follows, we will attempt to do justice not only to Jon's academic work, but also try to sketch a broader portrait of Jon's other contributions to economics as a gifted teacher, dedicated advisor, and selfless provider of public goods. Numerical references to Jon's papers cited in this essay are listed in Table 1.

## Biography

Unlike most economists, Jon's exposure to economics started not in the classroom, but at the dinner table. He was born in New Haven to Richard and Jane Levin, who both went on to prominent careers at Yale. Richard, a Professor of Economics,

■ *Liran Einav is Associate Professor of Economics, Stanford University, Stanford, California, and Research Associate, National Bureau of Economic Research, Cambridge, Massachusetts. Steve Tadelis is Associate Professor of Economics and Public Policy, Haas School of Business, University of California—Berkeley, Berkeley, California, and Distinguished Economist, eBay Research Labs, San Jose, California. Their e-mail addresses are <leinav@stanford.edu> and <stadelis@haas.berkeley.edu>.*



**Jonathan Levin**

is now serving as President of Yale University, while Jane, whose Ph.D. is in English literature, serves as the Director of Yale's selective interdisciplinary program for freshmen in Western Civilization. Jon and his three younger siblings were debating economic policy around the dinner table before most children learned how to spell "economics." We can only imagine how engaging these family conversations were by the fact that many years later, Jon was recruited by his father to help him in his role as the co-chair of the National Academy committee on patent reform. The paper that resulted from this collaboration [7] was important in shaping the America Invents Act, which was signed into law this past September.

We were told that, during a recruiting dinner at his home, Jon's puzzle-solving skills as a high school student helped his father recruit Barry Nalebuff to Yale. This experience even inspired Barry to employ Jon as a very young research assistant soon afterwards. Barry's engaging puzzles in math and economics (a number of which were published in the early issues of this journal from 1987 to 1990) piqued Jon's interests and led to a productive research collaboration. In fact, their joint paper [1] on vote-counting schemes, published in this journal, was Jon's first academic publication.

Jon pursued undergraduate studies at Stanford University, where he chose a double-major that reflected his two diverse passions, math and English literature. This combination of majors, which is not common for economists, provided superb training for a successful career in economics: be rigorous and write well! At Stanford,

Table 1

## Selected Papers by Jonathan Levin

- 
- 
1. "An Introduction to Vote-Counting Schemes," (with Barry Nalebuff). 1995. *Journal of Economic Perspectives* 9(1): 3–26.
  2. "An Optimal Auction for Complements." 1997. *Games and Economic Behavior* 18(2): 176–92.
  3. "Information and Competition in U.S. Forest Service Timber Auctions," (with Susan Athey). 2001. *Journal of Political Economy* 109(2): 375–417.
  4. "Information and the Market for Lemons." 2001. *RAND Journal of Economics* 32(4): 657–66.
  5. "Multilateral Contracting and the Employment Relationship." 2002. *Quarterly Journal of Economics* 117(3): 1075–1103.
  6. "Relational Incentive Contracts." 2003. *American Economic Review* 93(3): 835–47.
  7. "Patent Oppositions," (with Richard Levin). 2003. Chap. 13 in *Economics for an Imperfect World: Essays in Honor of Joseph Stiglitz*, edited by R. Arnott, B. Greenwald, R. Kanbur, and B. Nalebuff. Cambridge: MIT Press.
  8. "Profit Sharing and the Role of Professional Partnerships," (with Steve Tadelis). 2005. *Quarterly Journal of Economics* 120(1): 131–71.
  9. "Matching and Price Competition," (with Jeremy Bulow). 2006. *American Economic Review* 96(3): 652–68.
  10. "Estimating Dynamic Models of Imperfect Competition," (with Patrick Bajari and Lanier Benkard). 2007. *Econometrica* 75(5): 1331–70.
  11. "Liquidity Constraints and Imperfect Information in Subprime Lending," (with William Adams and Liran Einav). 2009. *American Economic Review* 99(1): 49–84.
  12. "Empirical Industrial Organization: A Progress Report," (with Liran Einav). 2010. *Journal of Economic Perspectives* 24(2): 145–62.
  13. "Online Advertising: Heterogeneity and Conflation in Market Design," (with Paul Milgrom). 2010. *American Economic Review* 100(2): 603–07.
  14. "Beyond Testing: Empirical Models of Insurance Markets," (with Liran Einav and Amy Finkelstein). 2010. *Annual Review of Economics* 2(1): 311–36.
  15. "Contracting for Government Services: Theory and Evidence from U.S. Cities," (with Steve Tadelis). 2010. *Journal of Industrial Economics* 58(3): 507–41.
  16. "Early Admissions at Selective Colleges," (with Christopher Avery). 2010. *American Economic Review* 100(5): 2125–56.
  17. "Comparing Open and Sealed Bid Auctions: Evidence from Timber Auctions," (with Susan Athey and Enrique Seira). 2011. *Quarterly Journal of Economics* 126(1): 207–57.
  18. "The Value of Information in Monotone Decision Problems," (with Susan Athey). 2001. <http://kuznets.fas.harvard.edu/~athey/VOI.pdf>.
  19. "Winning Play in Spectrum Auctions," (with Jeremy Bulow and Paul Milgrom). 2009. NBER Working Paper 14765.
  20. "The Impact of Information Technology on Consumer Lending," (with Liran Einav and Mark Jenkins). 2012. [http://www.stanford.edu/~leinav/Credit\\_Scoring.pdf](http://www.stanford.edu/~leinav/Credit_Scoring.pdf).
  21. "Contract Pricing in Consumer Credit Markets," (with Liran Einav and Mark Jenkins). Forthcoming. *Econometrica*.
  22. "Pricing and Welfare in Health Plan Choice," (with Kate Bundorf and Neale Mahoney). Forthcoming. *American Economic Review*.
  23. "Set-Asides and Subsidies in Auctions." (with Susan Athey and Dominic Coey). 2011.
  24. "The Economics of Internet Markets." Forthcoming. In *Advances in Economics and Econometrics*, vol. 4, edited by D. Acemoglu, M. Arellano, and E. Dekel. Cambridge University Press.
  25. "Designing Advanced Market Commitments for New Vaccines," (with Michael Kremer and Christopher Snyder). 2009. Unpublished paper.
  26. "Learning from Seller Experiments in Online Markets," (with Liran Einav, Theresa Kuchler, and Neel Sundaresan). 2011. NBER Working Paper 17385.
  27. "Sales Mechanisms in Online Markets: What Happened to Online Auctions?" (with Liran Einav, Chiara Farronato, and Neel Sundaresan). In progress.
  28. "Sales Taxes and Internet Commerce," (with Liran Einav, Dan Knoepfle, and Neel Sundaresan). In progress.
-

Jon studied intermediate microeconomics with Donald Brown, whom Jon had known as a child in New Haven. We were told that this engaging and demanding course was a turning point for Jon, persuading him that economics was his true calling.

After graduating from Stanford in 1994, Jon went on to pursue a Master's degree at Oxford University on a Fulbright scholarship. At Oxford, Jon took his first steps into auction theory under the supervision of Paul Klemperer. That early effort produced the second of Jon's publications [2]. From Oxford, Jon went on to obtain his Ph.D. from MIT, with Bengt Holmstrom, Glenn Ellison, and Jerry Hausman as his thesis advisors. Jon successfully completed his Ph.D. in 1999 after only three years, though "successfully" is somewhat of an understatement: four papers he wrote during his time at MIT were later published in the *American Economic Review* [6], *Quarterly Journal of Economics* [5], *Journal of Political Economy* [3], and *RAND Journal of Economics* [4]. Not a bad start.

After a year with a Cowles Foundation Post-Doctoral Fellowship, Jon accepted a position at Stanford in 2000, where he is now Professor of Economics and department chair. He was elected as a fellow of the Econometric Society in 2008, and is now on the editorial board of five leading journals.

## **Contracts and Organizations**

Long-term contractual relationships govern many economic transactions such as employer and employee, buyer and supplier, lender and borrower, and regulator and industry firms. What is striking, as Macaulay (1963) observed, is that many firms that engage in long-term contracts do not fully specify the contractual terms that govern their relationships. Instead, they rely on their ongoing relationships to fill gaps in the contract and to maintain gains from trade. In other words, the parties realize that the long-term value of their relationship can help direct behavior to be mutually beneficial.

The "relational contracts" literature has developed to study the conditions under which parties can use the threat of foregoing the value of their ongoing relationship to mitigate the hazards of one party pursuing short-term gains at the expense of the other party. In this setting, mutually beneficial trade is supported by self-enforcing contracts that do not require courts to intervene and impose sanctions. Early seminal developments by Telser (1980), Klein and Leffler (1981), and MacLeod and Malcomson (1989) laid the grounds for this prolific research agenda. However, these and most other papers study specialized contracts that are not necessarily optimal. Moreover, variations in the information structure available to the parties will influence their ability to form relational contracts, and the literature had not offered a consistent framework to address these important issues.

In [6], Jon unifies, generalizes, and extends the literature to study optimal contracts with a variety of information structures. To appreciate Jon's contribution, consider an ongoing (infinite horizon) relationship between an employer and employee. The employee's per-period effort determines per-period output,

which is owned by the employer. A relational contract specifies, for each period, (enforceable) per-period unconditional wages, a discretionary bonus payment that the employer promises to pay the employee, and the effort that the employee promises to exert. The earlier literature focused on the case where effort is observed and output is determined by effort. Jon's analysis generalizes the investigation to include two central informational variations: 1) the employee's effort is unobservable and output is stochastically determined by the employee's effort; and 2) the employee observes some random shock to production costs that is unobserved by the employer and the employee chooses how much to produce. The first involves the application of relational contract analysis to a dynamic version of Holmstrom's (1979) static "hidden action" problem, while the second involves the application of relational contract analysis to a dynamic version of Mirrlees' (1971) static "hidden information" problem.

Jon's analysis provides three key insights. First, when searching for the best (optimal) relational contract that the parties can achieve, it suffices to restrict attention to "stationary contracts" where in every period the contract is essentially the same. This striking result arises because unlike standard repeated games where players rely on "continuation payoffs" (promises of future payments) to provide incentives, in this setting the parties have *two* instruments to provide incentives: bonus payments made today and promised continuation payoffs from future surplus. As Jon shows, these instruments are perfect substitutes with risk-neutral parties. Hence, any contract in which the employer provides incentives using variation in continuation payoffs can be replaced using variation in bonus payments that provide the same incentives. Second, Jon shows that there is a "dynamic enforcement" constraint that characterizes the optimal stationary contract: namely, discretionary bonus payments can be neither too small (otherwise the employee will leave the relationship) nor too large (otherwise the employer will renege and terminate the relationship). This limits what the parties can enforce in lieu of court-enforced contracts that have no such limits. Last but not least, Jon also establishes important connections between the relational contracts framework and the well-established one-shot contracts frameworks of Mirrlees (1971) and Holmstrom (1979). This paper is Jon's most cited piece, and it has become the standard reference and workhorse model for this growing literature.

In [5], Jon applies his framework of relational contracts to address an important practical concern of firms: the design of workforce compensation schemes and incentives contracts. He opens the paper with some classic questions: "Why do firms hesitate to cut pay or lay off workers in economic downturns? Why do some firms promote the idea of lifelong employee commitment, while others explicitly back away from such policies or hire temporary workers with low tenure expectations?" Jon refers to studies and cases that suggest that many firms have encountered severe problems, or believe they would encounter problems, if they would change employees' benefit packages, or if they deviate from expected wage increases or perhaps even attempt to lower wages. Jon approaches the problem as one in which firms form contractual relationships with their workforce as a whole,

rather than have a collection of individual contractual relationships. Jon compares a firm's commitments to its workforce as a whole, which he refers to as "multilateral relational contracting," with commitments to individuals or smaller groups of employees, called "bilateral relational contracts." Using this approach, Jon reveals an important tradeoff. Multilateral contracting improves the firm's ability to offer implicit self-enforcing commitments, which in turn improves incentives. However, when these implicit commitments cover the whole workforce, it becomes difficult to adjust to changes in the business environment. In contrast, bilateral contracts facilitate workforce changes, at the cost of restricting the set of self-enforcing contracts and hence reducing incentives. Jon's analysis sheds light on the use of relative performance evaluation and the adoption of multitiered workforces, in which different well-defined groups are employed using distinct relational contracts. This paper showcases one of Jon's trademarks: begin with an interesting and important real-world question, offer a rigorous and elegant model to shed light on the question, and then use the model's insights to improve our understanding of the economic reasons for actual practices.

In addition to the choice of explicit and implicit contracts, a firm's choice of organizational form will also influence the incentives and productivity of its employees. The corporate form of organization dominates some industries, such as manufacturing, technology, and many service industries, while partnerships have been prominent in human capital-intensive professional services such as law, accounting, investment banking, management consulting, advertising, and medicine. Why do these patterns persist, and what can explain them? In [8], Jon and Steve Tadelis take the defining feature of a partnership to be the redistribution of profits among its partners, whereas with corporations, employees earn wages and owners are the residual claimants of profits. They show that profit-sharing leads individuals to be particularly selective as to whom they take on as partners, resulting in a higher quality of service than that of a corporation. The intuition is straightforward: if a group commits to split its output, then it will not take on an additional partner if the marginal output of that individual is less than the current average output. In contrast, a corporation will hire an employee as long as the marginal output of that employee exceeds the market wage. As a result, if clients are disadvantaged in assessing service quality, then partnerships tend to be a preferable mode of organization relative to a profit-maximizing corporation because they create an internal incentive to select high-quality agents. Thus, partnerships will emerge when two features are prominent: 1) human capital is responsible for product quality; and 2) clients are at a disadvantage relative to firms in assessing the ability of the firm's workforce. These two conditions are typical of professional services, but not of manufacturing or technology industries where partnerships are quite unusual, thus explaining the patterns that motivated the research question.

In another joint paper [15], Jon and Steve consider the fundamental question in the economics of organization as posed by Coase (1937): When should a firm choose to do part of the production process within the firm, and when should it buy inputs from the market? Their paper offers a model that combines standard agency

theory with transaction cost economics in the spirit of Williamson (1985), in which some processes are more complex and harder to contract for than others. The model highlights the make-or-buy trade-off along two dimensions. The choice to buy ensures productive efficiency, which is obtained by contracting with high-powered incentives, yet the organization must bear the costs of contract administration. The choice to make rather than buy unloads the burdens of administering contracts, but involves low-powered incentives that reduce productive efficiency. The application of their approach is less conventional in the organizational economics literature because it considers local governments as the “firms” with the choice of whether to provide services with their own employees or by contracting with private or public sector providers. The empirical analysis suggests that economic efficiency concerns seem to play an important role in the decisions of local governments to contract for services, but not surprisingly, politics plays a role too.

## **Market Design**

Market design scholars study how market rules and institutions affect outcomes, such as the efficient allocation of resources or the profits of the market designer. There are two central applications of market design: auction markets, and the design and engineering of matching markets. Matching markets describe situations in which one side of the market must be matched with another side, but for institutional reasons prices are not allowed to play a defining role. Jon has been active in both areas, integrating economic theory, novel empirical methods, and data to obtain interesting new insights.

As mentioned earlier, Jon’s interest in auctions dates back to his Master’s thesis at Oxford University where he studied under the supervision of Paul Klemperer. In [2], Jon considers the optimal selling mechanism for complementary items, and he outlines conditions for which the bundling of items in a standard auction is optimal, yet shows that in general bundling the items does not maximize revenue. Thus, a tension can arise between efficient allocation of items across buyers and the seller’s profit-maximization objective.

Jon continued his work on market design as a student at MIT, where he and Susan Athey (who taught there at the time) started a prolific partnership. They studied competitive bidding for federally owned timber, with the goal of understanding how different auction rules used by the government have affected competition. These papers combine rigorous theory and sophisticated estimation techniques to shed light on important government policy decisions. It was also one of the first empirical studies to focus on auctions with “scoring rules,” which are common in government procurement decisions. In [3], Jon and Susan investigate how firms can strategically exploit the scoring rule often used in Forest Service auctions. In these auctions, government agencies offer for sale tracts of forest where more than one kind of timber grows. The government agency first publishes its own estimate of how many trees of each type are present in the tract that is up for



bidding. Bidding firms can then form their own estimates, after which each firm lists a price per type of tree, which constitutes the firm's bid. The highest bidder is the firm for which the simple product of bid-prices and government-estimated quantities is the highest. The paper highlights the fact that firms can strategically skew their bids without affecting their total price, by raising bids on types of trees for which the government overestimated quantities while lowering prices on those that were underestimated.<sup>1</sup> By developing an equilibrium model of scoring auctions, Jon and Susan use a combination of bidding behavior and performance data after the auction to document strategically skewed bidding by participating firms. The paper highlights the consequences of skewed bidding for both the allocation of tracts across firms and the resulting revenues to the government.

In [17], Jon, Susan, and their student Enrique Seira study the relative performance of oral and sealed bid auctions, again using Forest Service auctions. The most famous result in auction theory, the "revenue equivalence theorem," states that under certain specific conditions, there should be no difference between these auction designs in terms of revenue, allocation, or entry. When these specific conditions fail, however, then different auction formats will result in different outcomes, affecting competition, revenues, and whether resources are allocated efficiently. The paper uses data on timber auctions in the Montana–Idaho border area, in which both oral and sealed bid auctions have been used. An advantage of the setting is that the choice of auction format was driven by exogenous factors and occasionally by explicit randomization. The paper shows that, consistent with some recent development in auction theory, sealed-bid auctions favor "weak" participants (those with a lower expected value from the auctioned object) and that prices in these auctions are higher than those in oral auctions. The analysis suggests that a lack of aggressive competition among the few large bidders could explain the departures from more competitive bidding in oral auctions. In addition to its applied contribution to the design of timber auctions, the paper brings together an impressive collection of methods that are needed to capture the deviations of timber auctions from the standard textbook auction setting, such as bidder asymmetries, unobserved heterogeneity, and a joint decision of bidding and participation.

In a follow-up paper [23], Jon, Susan, and their student Dominic Coey use an empirical approach similar to the one used in [17] to study alternative methods

<sup>1</sup> For example, imagine that the government estimates 500 Douglas fir trees (*D*) and 400 Western Hemlock trees (*W*). Imagine that Firm 1 bids \$90 for each *D* tree and \$80 for each *W* tree, while Firm 2 bids \$80 and \$100. The government uses its estimates, together with the firms' bids, to create a total bid per firm. The total bid of Firm 1 is then  $(\$90 \times 500) + (\$80 \times 400) = \$77,000$  while the total bid of Firm 2 is  $(\$80 \times 500) + (\$100 \times 400) = \$80,000$ , and Firm 2 is the winning bidder. Now, imagine that Firm 2 sends a surveyor to count the trees and as a result estimates that there are in fact 600 *D* trees and only 300 *W* trees. Instead of bidding \$80 and \$100 for the trees, it can change its bids to \$40 and \$150, respectively. Its total bid is still \$80,000, so it will win the auction, but if its estimates were correct then Firm 2 would only end up paying  $(\$40 \times 600) + (\$150 \times 300) = \$69,000$ , compared to paying  $(\$80 \times 600) + (\$100 \times 300) = \$78,000$  if it kept the original bids of \$80 and \$100 (which resulted in the same total bid). In equilibrium, both firms have an incentive to produce accurate estimates and to use these strategically.



for a government to achieve distributional goals in an auction. In particular, they compare the use of targeted subsidies, where some bidders receive a subsidy that makes them more competitive, to setting aside certain contracts for those disadvantaged bidders, as is standard practice in federal procurement and natural resource sales. Economic theory does not provide clear guidance on which approach should be preferred, but their empirical results suggest that relative to setting aside some contracts, subsidies increase both revenues and efficiency.

Many other government agencies use auctions to allocate contracts and resources. The auctions used by the United States and other countries to sell spectrum rights to telecommunications firms in the mid-1990s are perhaps the most famous among economists. Indeed, these auctions sparked a revival of interest in auction theory and practice. The involvement of prominent academics in the design of these auctions, and their general success, has helped demonstrate the effectiveness of modern economic theory. Nevertheless, there is little published research on how these large and complex auctions actually work. In [19], Jon, Jeremy Bulow, and Paul Milgrom point out that the “activity rules” in these auctions—rules that govern the eligibility of bidders to continue bidding in subsequent auction rounds as a function of their earlier bids—create the potential for substantial pricing anomalies. More importantly, they show that aggregate prices appear to be driven by bidder budgets rather than by the bidder valuations emphasized in standard auction theory papers. This insight stresses the shortcoming of applying standard models to some instances of bidding behavior and offers motivation for the study of bidders with hard budget constraints. The paper then provides insights into the ways in which sophisticated bidders can take advantage of pricing anomalies and discusses one particular high-stakes case of a spectrum auction where this happened.

Turning to the design of matching markets, two of the best-known examples are the market for medical residents and the market for college admissions. Again, these are settings where the price mechanism is ruled out, leading the market designer to solicit the preferences of the market participants in order to make efficient matches.

In [9], Jon and Jeremy Bulow consider the National Residency Matching Program, which uses a market design by Al Roth (Roth and Peranson 1999) that adapts the famous Gale–Shapley (1962) algorithm to assign medical school graduates to hospital residency positions. Motivated by an antitrust case claiming that the match depressed resident wages by preventing individualized salary negotiations, Jon and Jeremy analyze matching markets in which firms are restricted from varying their salary offers across individuals, so that matching takes place with each firm offering a fixed salary. They show that in such a market the equilibrium assignment is nearly efficient but wages are low and significantly compressed, while firm profits exceed those in any competitive equilibrium. This result suggests that the ability to make discriminatory offers can have a significant impact on the distribution of surplus in matching markets.

In [16], Jon and Chris Avery analyze the market for college admissions. They focus on “early admissions,” which has become a common feature of this market in

the last two decades. Many top colleges offer applicants the opportunity to choose one college to which they apply early, several months before the regular application deadline. The paper combines theory and supporting evidence to explain the importance of early admissions in matching between applicants who are enthusiastic about certain colleges, and the colleges that wish to admit enthusiastic applicants. The paper argues that the early admissions policy is a market institution that allows applicants to communicate their enthusiasm about their preferred college in a credible manner. In particular, the exclusionary nature of the policy generates a real opportunity cost, so an applicant who does not apply for early decision to a college signals less enthusiasm about being admitted there.

Finally, Jon's work with Michael Kremer and Chris Snyder [25] offers one more illustration of Jon's ability to take insights from economic theory and apply them in practice. They analyze the design of Advanced Market Commitments, which are targeted subsidy programs to encourage the development and introduction of vaccines and drugs for low-income countries. The basic concept has gained substantial currency in the development community. Unfortunately, the design that was envisioned involves committing to a subsidized price for spot market purchases until funds run out, and thus suffers from a serious incentive problem. Unless supply conditions are competitive, which they typically are not, firms have little incentive to invest in capacity to serve the full market because selling larger annual quantities does not increase the overall level of funds in the advanced market commitment program. The paper shows that this problem can be overcome by tying subsidies to long-term supply commitments, with contracts allocated through a competitive bidding mechanism.

## **Markets with Asymmetric Information: Subprime Lending and Health Insurance**

In recent years, especially after the economic downturn that started in late 2007, there has been much interest in exploring subprime lending and its consequences. In a series of papers with Liran Einav, and former students Will Adams and Mark Jenkins, Jon examines the organization of subprime automobile-loan markets. Some good fortune was in play here, perhaps confirming Louis Pasteur's "chance favors the prepared mind." This research originated in 2005, a few years before the term "subprime" became a household name—albeit in reference to the market for home mortgages rather than auto loans.

The papers from this project provide a revealing window into low-income, high-risk credit markets. The data, obtained from a large auto sales and financing company, shows that one-third of loan applicants have no bank account, the modal (annual) interest rate is almost 30 percent, and more than 60 percent of the loans end in default. The papers seek to understand the high demand for these loans, the constraints faced by borrowers, and the informational imperfections inherent in high-risk consumer lending. The work also develops a range of empirical approaches for studying contracting markets with moral hazard and adverse selection.

In [11], Jon, Liran, and Will describe several striking facts about subprime lending. First, the individuals in the subprime population appear highly liquidity constrained. Loan applicants are extremely sensitive to the required down payment, far more sensitive than they are to changes in car prices. Moreover, purchasing activity spikes dramatically in February and March, when consumers become eligible for early tax rebates. Indeed, the stark seasonality in demand can be linked to individuals eligible for large rebates under the federal Earned Income Tax Credit program. Second, lenders in this market for high-risk consumer credit face serious problems of adverse selection and moral hazard. Given a choice, high-risk borrowers tend to self-select into the largest loans, and default rates for all borrowers are very sensitive to the level of monthly payments. Distinguishing moral hazard from adverse selection is challenging because, as is typical in empirical studies of asymmetric information, these two distinct problems give rise to similar empirical patterns, which in this context is the positive correlation between default rates and loan amounts. Central features of [11] are the use of plausible exogenous variation in the loan amount to identify moral hazard separately, and the finding that it plays a central role in causing defaults.

In [21], Jon, Liran, and Mark develop a more complete model of demand that allows for a joint analysis of the demand for cars, the down payment decision, and the repayment outcomes. The paper then analyzes optimal contract design and quantifies the value of credit-scoring information and risk-based pricing in such a context. This paper is one of the first to incorporate supply-side restrictions in markets with moral hazard and adverse selection, thus illustrating how standard techniques from industrial organization can be extended to estimate demand systems for credit or insurance contracts. Although some extrapolation is needed to leap from automobile loans to home mortgages, many features documented in this paper seem to have played a central role in the recent subprime mortgage market meltdown, in which lax down payment requirements allowed borrowers to become highly leveraged and therefore vulnerable in the face of declining house prices and underlying income or liquidity risk.

In [20], the three authors complement the analysis of the value of risk-based financing by using data from before and after the auto loan company switched from a traditional lending model, with significant discretion at the dealership level, to a modern and highly automated system that used computerized risk models. In addition to the increase in profits through an obvious channel—better information allows more efficient screening of bad risks—the paper documents a surprisingly large increase in profits driven by the ability to customize larger and more expensive cars to better risks, and describes interesting patterns across dealerships within the organization.

Many of the informational and behavioral problems in credit markets are also relevant in insurance markets. In [22], Jon, Kate Bundorf, and former student Neale Mahoney study the pricing structure in employer-sponsored health insurance markets. The nature and regulation of employer-provided health insurance leads to consumers often facing the same prices even though different plans may have a

cost advantage in serving different populations. The paper develops and estimates an equilibrium model of demand and supply for differentiated products to assess the sorting inefficiency caused by this lack of variation in prices. The results suggest that plans do indeed have cost structures that favor particular sorting patterns—in particular, integrated delivery systems, such as Kaiser, seem to have a sizable cost advantage in serving those with poor health status. Yet the amount of sorting inefficiency caused by uniform pricing is limited, because demand for health insurance is relatively inelastic.

Despite the fact that the papers described in this section have been written during the more recent part of Jon's career, it is obvious that markets with asymmetric information have been on his mind for many years. In [4], which was part of Jon's Ph.D. thesis, he studies the relationship between information and trade in adverse selection markets. The paper uses a series of examples to show how changes in the degree of asymmetric information can have counterintuitive effects on the equilibrium quantity of trade. The paper is also related to another early paper in information economics [18], in which Jon and Susan Athey develop a more general approach to comparing information structures for Bayesian decisions by using monotone comparative statics methods to derive notions of informativeness for different kinds of economic decision problems.

## **Estimation of Dynamic Games**

Many problems in industrial organization revolve around industry dynamics: When does market leadership persist? What is the relationship between innovation and market power? How large are sunk costs of entry? What are the trade-offs between short-run pricing and long-run investment? These questions are often difficult to address using static models of competition, yet the use of dynamic models introduces a host of econometric and computational challenges. One of Jon's most cited papers [10], which is joint with Patrick Bajari and Lanier Benkard, develops a computationally feasible method for estimating dynamic models of imperfect competition. It has become the standard method that economists (mostly in industrial organization) use for empirical estimation of dynamic games.

This approach, which extends earlier influential work by Hotz and Miller (1993) on the estimation of dynamic decision problems, is one of several "two-steps approaches" that were proposed recently in order to ease the computational limitations associated with the nested fixed point approach attributed to Rust (1987). The basic idea is to first (flexibly) estimate the Markov decision rule, or "policy function." The policy function can be used to recover the agent's (expected) value function, which is done through forward simulations. Then, in the second step, one can recover the primitives of each agent's payoff function by choosing the parameters that best rationalize the observed behavior. Jon, Pat, and Lanier suggest doing this by comparing the computed value using the policy function estimated in the first stage and the value implied by alternative suboptimal policies. The parameters

are chosen by minimizing the cases where the alternative is predicted to be better than the actual policy.

An important advantage of this approach is that it is never necessary to calculate the equilibrium of the dynamic game, a property that significantly reduces the computational burden. It is both straightforward to implement and also allows users of this approach to apply it for continuous controls (rather than only discrete controls, as in other approaches). In the three years since its publication, the method has become the leading approach to estimate dynamic models of imperfect competition. Its computational ease has made such questions more feasible to study, and the number of applications that use it is rapidly growing. As examples of recent papers that have attracted significant attention, Ryan (forthcoming) uses this approach to study the dynamic implications of environmental regulation of cement plants, Holmes (2011) uses it to study the rollout of Wal-Mart stores, and Sweeting (2011) uses it to analyze the product positioning of radio stations.

## **Final Remarks**

We have tried to summarize Jon's contributions and display the remarkable depth and breadth of his academic work. We have neglected to mention some exciting work in the pipeline, which is establishing him as a leader of a rapidly growing new area of study: the economics of Internet markets. In [24], Jon surveys what we know and what we don't about the economics of the Internet. A glimpse of Jon's future publications in this area is evident in a series of new papers. In [13], Jon and Paul Milgrom study Internet advertising. In three working papers, [26], [27], and [28], Jon, with Liran Einav, Neel Sundaresan, and current students Chiara Farronato, Dan Knoepfle, and Theresa Kuchler, analyze new data from eBay to investigate seller experimentation on the Internet, the effect of online sales taxes, and the tradeoff between auctions and fixed prices in selling items online.

This new direction reflects one of the most admirable attributes of Jon's approach to research. He works on what interests him and consequently is having fun. Perhaps best captured in Jon's own words: "I think one of the nice things about being an academic is, as long as you keep an open mind, interesting questions come up and you can start to pursue them and see where they go. That's always been the way that I've done research in the past, and I expect that's how I'll continue to do it in the future" (Nguyen 2011). Some of Jon's open-minded views about research can be found in an article about current approaches in the field of industrial organization from two years ago in this journal [12].

Although the Clark Medal is about academic and professional contributions, we would be remiss if we did not add a more personal perspective on Jon. We both have had the pleasure of being Jon's colleagues and coauthors, and we share the honor of being his friends. We stress this friendship because beyond publishing

brilliant and influential work, Jon stands out for his personality, which can be summarized simply as being a real mensch.<sup>2</sup> It is for these reasons that we are extremely pleased to celebrate Jon's work and achievements. We willingly accept the risk of being perceived as overly adulating, knowing well that if anything, we have failed to truly convey Jon's qualities. Jon's demeanor is always that of respect and encouragement, and his genuine interest in others is apparent from the long list of students that Jon has mentored since starting his career at Stanford. Jon always gives more than he takes, and his colleagues benefit frequently from his generous professional advice.

Even as a professor, Jon does much more than just work. Sports like tennis, baseball, and hockey provided balance for Jon in his youth, and he has always been an active outdoorsman, pursuing hiking, mountain climbing, and kayaking from a young age. On one trip in 2002 with a close friend, Jon hiked up Mount Whitney, the tallest peak in the lower 48 states, with a kayak strapped to his back, before paddling down through the class V headwaters of the Kern River. This would make any proficient kayaker more than proud, but as the former President of the Stanford Kayaking Club, it was just another day in the water.

Jon and his wife Amy, who as a physician has her own demanding schedule, are together raising a lovely family of three bright and energetic children: Madeline, Benjamin, and Noah. The fact that Jon has achieved so much while being a devoted husband and father is testimony to his productivity and extraordinary work habits. Jon's parental responsibilities mean that he must be more cautious, and as such, has taken a break from the extreme outdoor activities he used to pursue. You are therefore unlikely to see him with a kayak on his back climbing a dangerous trail; his water adventures these days are taking place next to the toddlers' pool.

■ *We thank Richard Levin and Jon Levin for very helpful comments and background information.*

<sup>2</sup>The word "mensch," borrowed widely from Yiddish, informally means a person of integrity and honor; one that has admirable characteristics, such as fortitude and firmness of purpose. As Steve Levitt, a former Clark medalist himself, noted on his *Freakonomics* blog post (2011): "When it comes to Jon Levin I cannot remember anyone saying anything negative about him. (Of course, now that he has the Clark Medal that will likely change in a hurry!)"

## References

- Coase, Ronald H.** 1937. "The Nature of the Firm." *Economica* 4(16): 386–405.
- Gale, David, and Lloyd S. Shapley.** 1962. "College Admissions and the Stability of Marriage." *American Mathematical Monthly* 69(1): 9–14.
- Holmes, Thomas J.** 2011. "The Diffusion of Wal-Mart and Economies of Density." *Econometrica* 79(1): 253–302.
- Holmstrom, Bengt.** 1979. "Moral Hazard and Observability." *Bell Journal of Economics* 10(1): 74–91.
- Hotz, V. Joseph, and Robert A. Miller.** 1993. "Conditional Choice Probabilities and the Estimation of Dynamic Models." *Review of Economic Studies* 60(3): 497–529.
- Klein, Benjamin, and Keith Leffler.** 1981. "The Role of Market Forces in Assuring Contractual Performance." *Journal of Political Economy* 89(4): 615–41.
- Levitt, Steven D.** 2011. "Jonathan Levin: The Most Recent John Bates Clark Medal Winner." *Freakonomics* blog, June 1. <http://www.freakonomics.com/2011/06/01/jonathan-levin-the-most-recent-john-bates-clark-medal-winner/>.
- Macaulay, Stewart.** 1963. "Non-contractual Relations in Business: A Preliminary Study." *American Sociological Review* 28(1): 55–67.
- MacLeod, W. Bentley, and James M. Malcomson.** 1989. "Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment." *Econometrica* 57(2): 447–80.
- Mirrlees, James A.** 1971. "An Exploration in the Theory of Optimum Income Taxation." *Review of Economic Studies* 38(114): 175–208.
- Nguyen, Ivy.** 2011. "Professor Levin Wins Clark Medal for Econ Work." *Stanford Daily*, April, 19. <http://archive.stanforddaily.com/?p=1047664>.
- Roth, Alvin E., and Elliott Peranson.** 1999. "The Redesign of the Matching Market for American Physicians: Some Engineering Aspects of Economic Design." *American Economic Review* 89(4): 748–80.
- Rust, John.** 1987. "Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher." *Econometrica* 55(5): 999–1033.
- Ryan, Stephen P.** Forthcoming. "The Costs of Environmental Regulation in a Concentrated Industry." *Econometrica*.
- Sweeting, Andrew.** 2011. "Dynamic Product Positioning in Differentiated Product Industries: The Effect of Fees for Musical Performance Rights on the Commercial Radio Industry." [http://public.econ.duke.edu/~atsweet/SWEETING\\_formatsjan11.pdf](http://public.econ.duke.edu/~atsweet/SWEETING_formatsjan11.pdf).
- Telser, Lester G.** 1980. "A Theory of Self-Enforcing Agreements." *Journal of Business* 53(1): 27–44.
- Williamson, Oliver E.** 1985. *The Economic Institutions of Capitalism*. Free Press: New York, NY.



