

## Statement of Research Program

### *Research Program*

I work in two research streams. The first involves production and inventory management. The second involves experimental economics, investigating factors that affect cooperative and competitive behavior. Both streams investigate the behavioral factors that affect managerial decision-making and usually contain a major empirical component—the data comes either from the field or from the laboratory.

#### *Production and Inventory Management*

Work in this area includes a field-based project that applies operations research methods to develop decision support tools for solving problems in manufacturing. It also includes a laboratory project that investigates supply chain coordination and inventory management.

Being able to take a new theoretical idea into the field and use it to help solve a practical business problem is a demanding test of the usefulness of this new idea. A prime example of this research approach is my long-standing partnership with Jeppesen Sanderson, Inc. The Jeppesen work won the 2000 Franz Edelman Award [Katok et al., *Interfaces* 2000], (the premier award for implemented work in operations research, granted by the Institute for Operations Research and the Management Sciences: INFORMS) and was subsequently presented to a plenary session at the annual INFORMS conference. Production planning at Jeppesen involves a high degree of uncertainty because Jeppesen provides flight manuals and other aviation information to over 80% of pilots worldwide, and aviation information changes in unpredictable ways. To address this uncertainty Jeppesen managers proposed to invest in a new flexible print-on-demand technology, but were unable to justify this investment using standard methods. We worked closely with the managers at Jeppesen and developed a new method for justifying investment in flexible equipment that takes into account the *decision flexibility* this equipment provides [Katok et al. *NRL* 2003]. Decision flexibility comes from the ability to postpone making decisions until more relevant information (such as the true customer demand, or in the case of Jeppesen, actual expiration dates for aviation charts) becomes available, and this ability generates tangible benefits, that standard methods ignore. Jeppesen managers used the new method to help them successfully justify the investment by demonstrating cost reductions of nearly 10 percent and an increase in profit of 24 percent,

The Jeppesen project also involved problems in inventory management. The Jeppesen inventory problem is non-standard because aviation charts are perishable – when information changes charts must be re-issued. To help solve this problem we developed and implemented a dynamic-programming based decision support system for ordering outsourced aviation charts [Katok et al. *Interfaces* 2001], and then extended this approach to more general problems by developing and systematically testing three new heuristic solution methods [Katok and Xu Working Paper 2003].

The “bullwhip” effect refers to the observation that the variability of orders in supply chains increases as one moves closer to the source of production, and is a phenomenon that standard theory cannot fully explain. A major finding in a project funded by the National Science

Foundation through a collaborative grant with Rachel Croson (Wharton) [Croson et al. Working Paper 2003] was that the “bullwhip” effect persists in the laboratory in an environment with constant and publicly announced customer demand. There is strong evidence that even in this completely deterministic environment, having safety stock significantly improves performance because safety stock, which is traditionally thought of as a buffer against demand uncertainty, also serves as a successful buffer against human error.

The supply chain environment used to study the “bullwhip” effect is complex because it involves groups of subjects working together to simulate a serial supply chain. In order to better understand how individuals order inventory when coordination is not an issue, we look at a simpler environment in [Bolton and Katok, Working Paper 2003]. Here each individual faces a single period problem with stochastic customer demand, known as the “newsvendor” problem. The main finding is that providing people with information about the hypothetical outcomes of options not chosen speeds up learning substantially, and restricting decision-makers to placing the same order for multiple periods speeds up learning further. One managerial insight from this work is that variability of feedback makes it difficult to learn even in stable environments, so useful systems should decrease variability of feedback by allowing managers to see the “big picture.”

### *Experimental Economics*

Projects in this area investigate cooperative and competitive behavior in different institutional settings, including bargaining, reputation systems to promote trust in e-markets, and bidding behavior in auctions.

Field evidence suggests that arbitration increases disputes, and in [Bolton and Katok *GEB* 1998] we investigate the reasons. We find that bargainers learn to avoid disputes, but this learning is slower under arbitration. We then build on this work in [Bolton and Katok Working Paper 2003] by looking at environments with more than one outcome that can be justified as being fair. Here we find that arbitration actually speeds up learning when the arbitrator awards favor one of the natural focal points, but not when arbitrator attempts to “split the difference.”

We study ways individuals allocate resources between self and the group in [Bolton et al. *IJGT* 1998] by looking at a simple decision task called the “dictator game,” where one player, the dictator, divides a fixed amount of money between himself and one other. Consistent with the data is a simple model of dictator behavior based on the notion that generosity originates with personal and social norms that constrain self-interested behavior. We find further evidence in [Bolton et al. *Economic Theory* 2000] that people have non-linear preferences over own and the other player’s payoffs. In [Bolton and Katok *Economic Letters* 1995] we examine (and does not find any) differences between men and women in their willingness to contribute to the group.

On the Internet, electronic reputation systems are crucial for promoting cooperation among strangers in on-line markets. We develop a strategic framework for studying reputation systems in the laboratory in [Bolton et al. In Press], and in we [Bolton et al. Working Paper 2003] look at the amount of information necessary to promote trade among strangers and find that systems that provide much less information than traditional theory suggests promote trade significantly. In

[Bolton et al. *Management Science* In Press] we compare trading in a market with online feedback (as implemented by many Internet markets) to a market without feedback, as well as to a market in which the same people interact with one another repeatedly (partners market). We find that, while the feedback mechanism induces a substantial improvement in transaction efficiency, it also exhibits a kind of public goods problem in that, unlike in the partners market, the benefits of trust and trustworthy behavior go to the whole community and are not completely internalized.

In [Katok et al. *JET* 2002] we use the laboratory to compare two mechanisms for implementing desired outcomes that use alternative solution concepts—iterative dominance and backwards induction—and find that, contrary to a popular belief, sequential mechanisms are not more successful than simultaneous mechanisms. In [Katok and Roth Working Paper 2003] we compare two multi-unit auction mechanisms often used for procurement in business-to-business (B2B) settings and find that overall the Dutch (real time descending price) auction performs well in a variety of environments, although there are some situations in which the ascending uniform-price auction similar to the one used by eBay performs better. Bidding in on-line auctions can be time consuming, and in [Katok and Kwasnica Working Paper 2003] we investigate, theoretically and empirically, the effect impatience has on bidding behavior and find that impatience can explain laboratory data.