Manufacturing & Service Operations Management

MSOM Society Student Paper Competition: Abstracts of 2011 Winners

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MSOM Society Student Paper Competition: Abstracts of 2011 Winners

The journal is pleased to publish the abstracts of the seven finalists of the 2011 Manufacturing and Service Operations Management Society's student paper competition.

The 2011 prize committee was chaired by Gad Allon and Achal Bassamboo (Kellogg School of Management, Northwestern University). The other committee members were Aydın Alptekinoğlu, Atalay Atasu, Göker Aydın, Omar Besbes, Metin Çakanyıldırım, Felipe Caro, Carri Chan, Li Chen, Ying-Ju Chen, Stephen Chick, Soo-Haeng Cho, Jiri Chod, Laurens Debo, Sarang Deo, Lingxiu Dong, Karen Donohue, Cheryl Druehl, Qi Feng, Mark Ferguson, Jan Fransoo, Vishal Gaur, Itay Gurvich, Dorothee Honhon, Xinxin Hu, Otis Jennings, Eda Kemahlioğlu-Ziya, Harish Krishnan, Guoming Lai, Lauren Lu, Qian Liu, Victor Martínez-de-Albéniz, John Neale, Marcelo Olivares, Ali Parlakturk, Guillaume Roels, Paat Rusmevichientong, Ozge Sahin, Kesavan Saravana, Kevin Shang, Hyoduk Shin, Robert Shumsky, Amitabh Sinha, Larry Snyder, Greys Sošić, Richard Steinberg, Xuanming Su, Ravi Subramanian, Senthil Veeraraghavan, Amy Ward, Gabriel Weintraub, Wenqiang Xiao, Xiaowei Xu, Yi Xu, Nan Yang, Wu Yaozhong, Fuqiang Zhang, Jiawei Zhang, Yao Zhao, Shaohui Zheng, Leon Zhu, and Serhan Ziya.

The 2011 prize winners are as follows:

First Prize
Jun Li, University of Pennsylvania
"Are Consumers Strategic? Structural Estimation from the Air-Travel Industry"

Second Prize
Turgay Ayer, Georgia Institute of Technology
"Personalizing Breast Cancer Screening Policies"

Finalists
Sam Aflaki, INSEAD
"Strategic Investment in Renewable Energy Sources"

Yasin Alan, Cornell University
"Operational Investment and Capital Structure Under Asset-Based
Lending: A One-Period Model"

Kenan Arifoğlu, Northwestern University
"Consumption Externality and Yield Uncertainty in the Influenza Vaccine
Supply Chain: Interventions in Demand and Supply Sides"

Robert L. Bray, Stanford University
"Information Transmission and the Bullwhip Effect: An Empirical Investigation"

Morvarid Rahmani, University of California, Los Angeles
"Contracting and the Dynamics of Collaboration"

Are Consumers Strategic? Structural Estimation from the Air-Travel Industry

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Advisor: Serguei Netessine, INSEAD

Many consumers have learned to delay purchases, anticipating that prices might decrease. Such strategic or forward-looking behavior has attracted increasing attention from various disciplines, including operations management, information systems, marketing, and economics. However, there is currently no empirical evidence of the extent to which this strategic decision making actually takes place. Combining two unique data sources from the air-travel industry (posted fares data and booking data), we use a structural model to estimate the fraction of strategic consumers in the population, assuming different levels of sophistication in consumers' perception of future prices: perfect foresight and rational expectations. We find that 4.9% to 44.9% of the population is strategic across markets, measured by the 5th and 95th percentiles. Using a nonparametric approach, we further find that most strategic consumers arrive either at the beginning of the booking horizon or close to departure. Finally, our counterfactual analysis shows that, contrary to conventional wisdom, the presence of strategic consumers does not necessarily hurt revenues. Rather, the impact varies by market—more likely to be negative on business markets and positive on leisure markets. As a result, commitment to a nondecreasing pricing strategy benefits business markets but not leisure markets. Among markets benefiting from this pricing strategy, the median revenue improvement is 3.5%, and the quartiles are 1.8% and 5.6%.

Personalizing Breast Cancer Screening Policies

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Breast cancer is the most common nonskin cancer and the second leading cause of cancer death in U.S. women. Although mammography is the most effective modality for breast cancer screening, it has several potential risks, including high false-positive rates. Therefore, the balance of benefits and risks, which depend on personal characteristics, is critical in designing a mammography screening schedule. In contrast to prior research and existing guidelines which consider population-based screening recommendations, we propose a personalized mammography screening policy based on the prior screening history and personal risk characteristics of women. We formulate a finite-horizon partially observable Markov decision process (POMDP) model for this problem. Our POMDP model incorporates two methods of detection (self or screen), age-specific unobservable disease progression, and age-specific mammography test characteristics. We solve this POMDP optimally after setting transition probabilities to values estimated from a validated microsimulation model. Additional published data is used to specify other model inputs such as sensitivity and specificity of test results. Our results show that our proposed personalized screening schedules outperform the existing guidelines with respect to the total expected quality-adjusted life years, while significantly decreasing the number of mammograms {and false-positives}. We further derive several structural properties of the model, including sufficiency conditions that ensure the existence of a control-limit policy.

Strategic Investment in Renewable Energy Sources

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Abstract: In this paper we model the trade-off between investing in a renewable (e.g. wind) and a nonrenewable technology (e.g., natural gas). The renewable technology has higher investment cost and is intermittent—i.e., its electricity supply is uncertain. The nonrenewable technology is reliable and has a lower investment cost but entails variable (fuel) expenditures and emission (carbon) costs. Motivated by existing electricity markets, we model several interrelated contexts, including vertically integrated electricity supplier, market competition, and partial market competition with long-term fixed-price contracts for renewable electricity. Within these contexts we examine the impact of carbon taxes on the share of renewables in the total capacity portfolio. We find that intermittency is the critical aspect of renewable technologies, which drives the effectiveness of carbon pricing mechanisms. Our results suggest that, due to intermittency of supply and the need for backup generating capacity, increasing the price of carbon emissions may have an unexpected adverse effect on the investment in renewables. Additionally, we show that market liberalization can have a negative effect

on the investment in renewable capacity, total cost, and total emissions. Fixed price contracts with renewable generators can mitigate these detrimental effects, but they may also lead to excess renewable capacity and insufficient nonrenewable capacity that serves complementary role for backup generation. We conclude that actions toward reducing the intermittency of the renewable energy sources (e.g., through capacity pooling or unit-specific buffering) may be more effective in promoting investment in renewables than reliance on carbon taxes alone.

Operational Investment and Capital Structure Under Asset-Based Lending: A One-Period Model

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Classical operations management models implicitly assume that a firm has sufficient working capital to finance its operations. Such models can mimic operational decisions of a large corporation with ample cash and borrowing ability. However, most small- and medium-sized businesses face liquidity constraints. Banks commonly use asset-based lending (ABL) to lend money to small firms and improve their liquidity. In ABL, a bank sets a maximum lending amount linked to the current assets of a borrower firm, including inventory and account receivables. We study the implications of this lending mechanism for operational investment, probability of bankruptcy, and capital structure for a borrower firm. We set up a single-period game with two players, a business owner and a bank. The business owner decides how to allocate her capital between the equity of a new business and the external capital market in order to maximize her expected profit. We model the new business as a single-period inventory (newsvendor) model. The bank has partial information about the newsvendor's demand, and sets an asset-based credit limit in order to prevent overborrowing. We show that the equilibrium order quantity is a function of market parameters and deviates from the classical newsvendor solution. In this solution, ABL leads to an upper limit on the potential loss faced by the bank and thus helps manage bankruptcy risk. Moreover, the equilibrium probability of bankruptcy is either zero or a positive scalar that is a function of information asymmetry, bankruptcy costs, and the newsvendor model parameters. Lastly, we illustrate how detailed modeling of operational dynamics and financial constraints reconciles some of the gaps between theoretical models and empirical findings in the corporate finance literature.

Consumption Externality and Yield Uncertainty in the Influenza Vaccine Supply Chain: Interventions in Demand and Supply Sides

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We study the impact of yield uncertainty (supply side) and self-interested consumers (demand side) on the inefficiency in the influenza vaccine supply chain. Previous economic studies, focusing on demand side, find that the equilibrium demand is always less than the socially optimal demand since self-interested individuals do not internalize the social benefit of protecting others via reduced infectiousness (positive externality). In contrast, we show that the equilibrium demand can be greater than the socially optimal demand after accounting for the limited supply due to yield uncertainty and manufacturer's incentives. The main driver for this result is a second (negative) externality: self-interested individuals ignore that vaccinating people with high infection costs is more beneficial for the society when supply is limited. We show that the extent of the negative externality can be reduced through more efficient and less uncertain allocation mechanisms. In order to investigate the relative effectiveness of government interventions on supply and demand sides under various demand and supply characteristics, we construct two partially centralized scenarios, where the social planner (government) intervenes either on the demand side or the supply side but not both, and conduct an extensive numerical analysis.

Information Transmission and the Bullwhip Effect: An Empirical Investigation

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The bullwhip effect is the amplification of demand variability along a supply chain: a company bullwhips if it purchases from suppliers more variably than it sells to customers. Such bullwhips (amplifications of demand variability) can lead to mismatches between demand and production and hence to lower supply chain efficiency. We investigate the bullwhip effect in a sample of 4,689 public U.S. companies over 1974–2008. Overall, about two-thirds of

firms bullwhip. The sample's mean and median bullwhips, both significantly positive, respectively measure 15.8% and 6.7% of total demand variability. Put another way, the mean quarterly standard deviation of upstream orders exceeds that of demand by $20 million. We decompose the bullwhip by information transmission lead time. Estimating the bullwhip's information-lead-time components with a two-stage estimator, we find that demand signals firms observe with more than three-quarters' notice drive 30% of the bullwhip, and those firms observe with less than one-quarter's notice drive 51%. From 1974–1994 to 1995–2008, our sample's mean bullwhip dropped by a third.

Contracting and the Dynamics of Collaboration

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Collaboration governs many work processes; for example, it is common in business-to-business services. In this paper, we study when work is done collaboratively or individually in a joint project with a deadline, and characterize the work dynamics over time. In particular, we study when collaboration takes place, and how the dynamics of collaboration are affected by the project deadline, the verifiability of efforts, and the type of contract adopted by the parties involved in the project. We model the work process as a dynamic stochastic game between two parties; say a buyer and a vendor. We show that, if efforts are verifiable, collaboration arises when the project is nearly completed, either because it has reached a high state or because there is limited time left before the project deadline. When efforts are not verifiable, the dynamics of collaboration strongly depend on the type of contract: Revenue-sharing contracts yield less collaboration and lower output than if efforts were verifiable. Fixed-wage contracts do not induce collaboration near the project deadline and provide low incentives for the vendor to work alone. Collaboration may, however, arise in the high states of the project, because the vendor wants to be paid sooner than later. By contrast, time-and-material contracts never lead to collaboration. In particular, the buyer works alone in the low states, when her reward prospects are low, and the vendor works alone in the high states, so as to keep the project and his paycheck running.